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The Impact of Intelligent Unmanned Stores in the Context of New Retail:A Case Study of JD Intelligent Unmanned Store

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Master Degree in Business Administration

Supervisor:
PhD, Henrique José da Rocha O'Neill, Associate Professor with habilitation
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**BUSINESS
SCHOOL**

Department of Marketing, Strategy and Operations

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Abstract

With the development of digital technologies - cloud computing, machine in-depth learning, computer vision,Internet of things, wireless sensor technology, big data, intelligent tracking, mobile payment and other artificial intelligence technologies - it becomes possible the normal development and operation of intelligent shopping settlement systems in intelligent unmanned stores.Intelligent unmanned stores are different from traditional unmanned stores, which are similar to self-service settlement of supermarkets, The self-service settlement system scans the commodity QR code to obtain the commodity price for system settlement. The intelligent unmanned store first reflects intelligence, followed by unmanned. Through the intelligent shopping system, automated operations such as entering the store, intelligent shopping, intelligent settlement, and leaving the store are completed. Customers are unaware of the completion of product settlement by the intelligent shopping system, and only need facial recognition, palm print recognition, and entering the settlement area to complete the settlement without perception.

At the beginning of the birth of intelligent unmanned stores, the goal is to save manpower costs, reduce the waiting time of customers' shopping queue, improve the convenience of shopping, improve the shopping experience of consumers, and improve the profits of retail stores. With a large population in the world, retailers can choose to be unattended or manned for intelligent stores. However, But as the population of some countries decreases, the improvement of the overall quality of the world population, the progress of science and technology, and the upgrading of human occupation, many more retail enterprises can only choose to be unattended. Saving human resources, improving consumers' shopping experience, ensuring the safety of intelligent unmanned stores and reducing enterprise R&D costs will become the main goals.

Since I have participated in the research and development of the visual intelligent shopping system of JD intelligent unmanned store, which is one of the world's top 500 enterprises, this dissertation will take JD intelligent unmanned store as the research object, through the analysis of its visual intelligent shopping system solution, put forward the advantages and problems of this solution, and compares it with Amazon Go, Alibaba TaoCoffee and other intelligent shopping settlement

system solutions, find out their advantages and existing problems, help enterprises avoid technical risks, reduce costs and increase efficiency, and improve ROI. Finally, through the questionnaire survey of about 300 R&D personnel or high-quality consumers, this dissertation analyzes the impact of different factors on the customer experience of intelligent shopping solutions in intelligent unmanned stores of different retail enterprises

from the perspectives of entering stores, intelligent shopping, intelligent settlement, leaving stores.

Resumo

Com o desenvolvimento das tecnologias digitais - computação em nuvem, aprendizagem máquina, visão computacional, Internet das coisas, tecnologia de sensores sem fios, big data, rastreamento inteligente, pagamento móvel e outras tecnologias de inteligência artificial - torna-se possível o desenvolvimento e a operação de sistemas inteligentes de liquidação de compras em lojas inteligentes não tripuladas ou de serviço automático. As lojas inteligentes de serviço automático são diferentes das lojas tradicionais de serviço autónomo, que são representadas pelos supermercados com pagamento por autosserviço. O sistema de pagamento por autosserviço lê o código QR da embalagem para obter o preço para liquidação da mercadoria no sistema. A loja inteligente de serviço automático reflete primeiro a inteligência, e depois o facto de ser não tripulada. Através do sistema de compras inteligente, é possível automatizar todas as operações do cliente como entrar na loja, comprar, apurar a despesa, efetuar o pagamento e sair da loja. Os clientes não se apercebem da conclusão da transação do produto pelo sistema de compras inteligente e só necessitam de reconhecimento facial, reconhecimento da palma da mão e de entrar na área de exposição para recolher o produto e concluir a compra.

Os objetivos das lojas inteligentes de serviço automático são economizar os custos de mão de obra, reduzir o tempo de espera dos clientes na fila de compras, melhorar a conveniência das compras, melhorar a experiência de compra dos consumidores e aumentar os lucros das lojas de retalho. Com o aumento do número de consumidores, os retalhistas podem optar por lojas inteligentes autónomas. No entanto, à medida que a população ativa de alguns países decresce, mas aumenta o nível de qualificação geral da força de trabalho, o progresso da ciência e da tecnologia e a modernização da ocupação humana, muitas mais empresas de retalho só podem optar por soluções inteligentes de serviço automático. Poupar recursos humanos, melhorar a experiência de compra dos consumidores, garantir a segurança de lojas inteligentes não tripuladas e reduzir os custos de I&D empresariais tornar-se -ão objetivos prioritários do retalho.

Tendo participado na pesquisa e desenvolvimento do sistema inteligente e visual de compras da loja não tripulada da JD, que é uma das 500 maiores empresas do mundo, esta tese considera a loja não tripulada inteligente JD como objeto de

pesquisa. Através da análise do seu sistema inteligente de compras, a dissertação apresenta as vantagens e problemas desta solução e compara-a com as soluções da Amazon Go, Alibaba, TaoCoffee e outros sistemas de liquidação de compras inteligentes, identifica as suas vantagens e os problemas existentes, procurando ajudar as empresas a mitigar riscos técnicos, reduzir custos e aumentar eficiência, bem como melhorar o ROI. Finalmente, através de um inquérito realizado a cerca de 300 profissionais de I&D e consumidores diferenciados, esta dissertação analisa o impacto na

experiência do cliente das diferentes características presentes em soluções de compras em lojas inteligentes não tripuladas de diferentes empresas retalhistas, a partir da jornada do cliente que inclui etapas como a entrada na loja, a compra inteligente, a liquidação inteligente e a saída da loja.

General Index

Index of Tables

Index of Figures

x

List of Abbreviations

AI – Artificial Intelligence
AIoT – Artificial Intelligence & Internet of Things
BI – Business Intelligence
BA – Business Analysis
CNN – Convolutional Neural Network
CV – Computer Vision
DL – Deep Learning
DS – Data Science
DNN – Deep Neural Networks
EU – European Union
GAN – Generative Adversarial Network
GPT – Generative Pre-Trained Transformer
IOT – Internet of Things
ISS – Intelligent shopping solutions
IUS – Intelligent unmanned store
LLM – Large Language Model
ML – Machine Learning
NLP – Natural Language Processing
RNN – Recursive Neural Network
ROI – Return On Investment
RPA – Robotic Process Automation
RS – Recommender System
SVM – Support Vector Machine
TBL – Triple Bottom Line
UN – United Nations

Chapter 1 – Introduction

1.1. Research Background

With the progress of science and technology, the development of artificial intelligence, big data, cloud computing, 5G, Internet of things, mobile payment and other technologies, the realization of intelligent unmanned retail in the integration of intelligent unmanned sales has become a reality, and at the same time, consumers' consumption structure has been constantly changing, With the personalization and diversification of consumers' consumption patterns, the development of intelligent unmanned retail has also started. Especially affected by the COVID-19 pandemic, the "contactless" service of intelligent unmanned retail has become popular. When people have to go out shopping and pick up goods, they are more willing to choose intelligent unmanned convenience stores and intelligent unmanned containers.

The Internet and mobile Internet have brought a huge impact on the traditional retail industry. Many retailers began to seek the transformation of business model and direction. With the depletion of e-commerce traffic dividends, the retail industry is facing transformation again.

In a narrow sense, intelligent unmanned retail refers to the unattended part of physical retail, which is mainly composed of open shelves, vending machines, unmanned convenience stores and unmanned supermarkets. Although nobody is on duty, the management behind it still needs someone, but the role of people has changed. The front-end personnel are mainly responsible for distribution, tallying and cleaning. At present, unattended retail can be "unattended", or "few people" (a small number of administrators), or switched flexibly.

In this dissertation, the intelligent unmanned store usually refers to intelligent unmanned convenience store and intelligent unmanned supermarket.

1.1.1. Background of Intelligent Unmanned Stores in the New Retail Field

Intelligent unmanned store is an emerging industry in the new retail field. With the continuous development of artificial intelligence technology and the increasing demand for convenient shopping and intelligent shopping experience, intelligent

unmanned supermarket and intelligent unmanned convenience store will have a very broad development prospect. According to market data from Zhiyan Consulting (2018), the transaction volume of intelligent unmanned retail stores is expected to reach 38.94 billion yuan in 2017. In the next five years, intelligent unmanned retail stores will usher in a development dividend period. The growth rate is expected to reach 281.3% in 2020, and the market transaction volume will exceed 1.8 trillion yuan by 2022. It is estimated that the sales scale will reach 2trillion yuan in 2025, and the consumer group will reach 250million. The development of intelligent unmanned stores will also benefit from the acceleration of population aging and urbanization, as well as the increasing demand of consumers for convenient, efficient and intelligent consumption.

Zhiyan Consulting (2018)
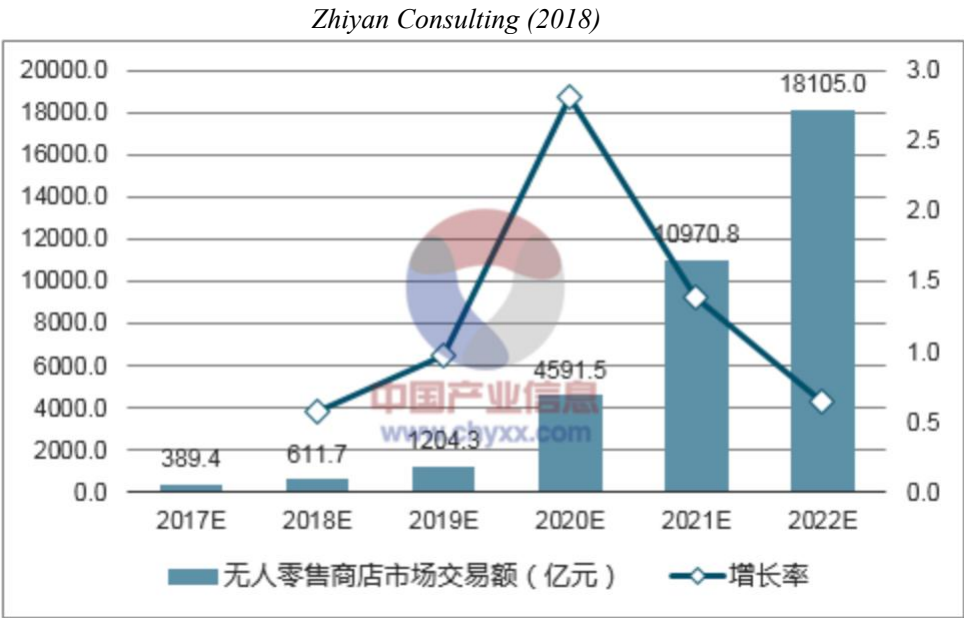
Figure 1.1 China's unmanned retail store market transaction volume

The market pattern of the intelligent unmanned store industry has not yet formed an obvious monopoly, and the market is in a competitive state. Many unmanned supermarket brands have sprung up at home and abroad, and foreign brands such as Amazon Go, zippin, grab&go have emerged early. Domestic brands such as JD unmanned supermarket, JD convenience store, F5 future store, take go, HEMA unmanned store, 7fresh unmanned convenience store, Taobao unmanned supermarket, Tao coffee, etc.

In the international market, Liu Xufei (2017) indicates that Amazon Go, the American e-commerce giant, opened its first unmanned retail convenience store in Seattle. Amazon Go is one of the most representative brands of intelligent unmanned stores, and has opened unmanned stores in many cities in the United States. It has subverted the operation mode of traditional convenience stores and supermarkets, and completely skipped the traditional checkout process by using technologies such as computer vision, in-depth learning and sensor touch. The Sports Research Center of Tsinghua University(2023) indicates that zippin is a intelligent and unmanned store startup company headquartered in San Francisco, the United States. Its unmanned supermarket technology has been applied in many regions of the United States and around the world. It operates more than 90 stores around the world, distributed in airports, railway stations and office parks. In 2022, zippin launched a new zippin lane, a smaller and cheaper unmanned store. In 2022, more than 20 zippin lanes were launched in the United States.

In the domestic market, 168report indicates that HEMA unmanned store is one of the largest unmanned supermarket brands, and has opened unmanned stores in many cities, including Shanghai, Beijing, Hangzhou, Nanjing, etc. 7fresh unmanned convenience stores have also opened stores in many cities, such as Beijing, Shanghai, Shenzhen, etc. Taobao unmanned supermarkets are mainly concentrated in Hangzhou. JD unmanned convenience stores are only available at JD headquarters for JD employees to experience, and are not open to the public for the time being. JD unmanned supermarkets have been opened all over China.

From the Internet

Figure 1.2 Amazon intelligence unmanned convenience store

1.1.2. Application Background of Artificial Intelligence in Unmanned Stores

With the gradual maturity of emerging technologies such as artificial intelligence, face recognition, Internet of things, intelligent tracking, and the domestic and global leading trend of mobile payment, the new retail represented by unmanned retail has attracted the attention of major e-commerce platforms and well-known brands. Intelligent unmanned store has become a new trend in the global retail industry. Traditional retail giants such as Alibaba and JD have begun to try the intelligent unmanned store model, and some small and medium-sized start-ups have also emerged with their industry-leading AI technology. After sharing bicycles, intelligent unmanned stores are expected to become the next emerging business.

With the development of AI technology, the application of AI technology in intelligent unmanned stores has the following characteristics:

1. Provide customized requirements

In the context of increasingly diversified consumer demand, intelligent unmanned stores need to better meet the customized needs of customers through artificial intelligence technology.

For example, accurately recommend goods through shopping history, browsing records and other information; Provide better customized services through social interaction, intelligent customer service, etc.

2. Intelligent big data analysis

Intelligent big data is widely used in intelligent unmanned stores. In the whole process of sales, operation and service, it is necessary to use intelligent big data, artificial intelligence and other emerging technologies to conduct a comprehensive and multi-dimensional data analysis on customer behavior, shopping preferences and other aspects, so as to improve sales efficiency, optimize service experience and promote revenue growth.

3. Intelligent e-commerce system makes the combination of online and offline a reality

The intelligent unmanned store realizes the organic combination of online and offline through the intelligent system, and creates a brand-new consumption scene and shopping experience. For example, offline stores can give full play to their scene advantages and enhance customer participation.

With the continuous integration of online and offline, under this background, the price of goods, shopping experience and product quality will be unified, and consumers will get more professional services and higher quality products.

4. digital empowerment

Intelligent unmanned stores use digital knowledge and technology to empower shopping processes, operations and services. Digital empowerment includes: Technology empowerment, ecological empowerment, market empowerment, talent empowerment and other enabling scenarios. Enabling can enable intelligent unmanned stores to get rid of a single supply, deeply tap customer demand, and explore diversified business scenarios. The basic principle of digital enabling is to start from business and take scenario application as the guide. Different enabling methods are used according to different strategic purposes, so as to reduce relevant costs and improve efficiency.

5. intelligent technology and technological development

The continuous development of new technologies such as Internet, artificial intelligence, Internet of things, big data, cloud computing and so on has injected high-speed growth power into intelligent unmanned stores. The application of these technologies can greatly improve the shopping efficiency and accuracy of intelligent unmanned stores, and further enhance the shopping experience of consumers.

Intelligent unmanned stores use information technology to realize the development of technology and business capabilities from scratch and from weak to strong. The key technologies in this process include Internet of things, cloud

computing, big data/artificial intelligence and security. Among them, the Internet of things acts as the end under the premise of connection to realize the data receiving and sending; Cloud computing, as the foundation, provides programmable infrastructure, advanced processes and methods, and service-oriented software architecture to improve the efficiency of office collaboration, product development, production and transportation, and sales services; Direct or indirect data realization through big data/artificial intelligence is the means to realize the value of digital innovation; Security technology provides protection for this process. With the complexity and fragmentation of security operations increasing, the use of professional security cloud services will become a reliable choice for intelligent unmanned stores.

1.1.3. Background of JD Intelligent Unmanned Store

JD intelligent unmanned store mainly includes two types of stores, JD unmanned convenience store and JD unmanned supermarket. Since the emergence of new retail in 2016 and sessionless retail in 2017, Amazon launched Amazon Go unmanned convenience store, Alibaba launched unmanned "TaoCoffee", JD launched intelligent unmanned convenience store and intelligent x unmanned supermarket, and the three major e-commerce giants at home and abroad began to promote the transformation of offline stores. First Financial (2016) pointed out that,As far as JD is concerned, in 2017, liuqiangdong mentioned that the next 12 years of JD are the 12 years of technology. JD's business units strive to improve productivity around "technology". Only six business departments are developing the "unmanned store" scheme at the same time. JD unmanned convenience store is developed by JD data innovation research department. Behind it, d-mart is the world's first low-cost, modular intelligent store solution. Due to modularity, it can be combined at will, and the existing traditional mom and pop stores and convenience stores can be partially or comprehensively transformed. JDX unmanned supermarket, which covers the whole scene of unmanned stores, is in the charge of JDX business department, which was established in May 2016. JD mall's mid platform R&D system and logistics R&D department are jointly built. The R&D cycle is about one year. The unmanned aerial

6

vehicles, unmanned vehicles and unmanned warehouses in JD intelligent logistics system are in the charge of X business department.

Since JD convenience store was launched in September 2017, it has had 12000 offline stores by 2023, and an average of one store is added every month. On April 10, 2018, JD's first JDX unmanned supermarket in Jilin Province was officially opened in Changchun. As of July 2019, JD unmanned supermarket has opened stores in Beijing, Xiong An and other places.

So far, JD intelligent unmanned convenience store has not been promoted temporarily due to technical reasons and is only retained in JD headquarters. JD unmanned convenience store and JDX unmanned supermarket are both JD offline store management technology solutions. The key to the unmanned store is intelligence. Using technology to improve the efficiency of traditional stores and reduce costs is the key to the "unmanned store". More importantly, these technologies can be extended to other fields, which is of epoch-making significance to the development of science and technology.

From the Internet

Figure 1.3 JD unmanned convenience store and JDX unmanned supermarket

1.2. Research Problem

The emergence and development of new things are accompanied by risks. Some can promote the development of productivity and the progress of human society, while others may not be able to develop productivity and promote the progress of human society for some reasons. In the new retail field, the development of artificial intelligence technology has brought opportunities to the development of intelligent unmanned stores, but at the same time, we should also see the advantages and disadvantages of the development of intelligent unmanned stores.With the development of artificial intelligence technology, artificial intelligence has become the inevitable trend of social development, but its development in some fields is challenged, especially in the new retail intelligent unmanned store.

We know that artificial intelligence has formed products applied to human beings through the combination of algorithm, knowledge base and training, such as face recognition, chatgpt, robot, intelligent recognition, intelligent tracking, intelligent store, intelligent city, etc. Although some of these products are mature products, they are all doing the same thing, that is, improving the accuracy/recognition rate. Many products fail to sell because of low accuracy or recognition rate. However, especially in the field of intelligent identification of multi person shopping in new retail, accuracy has become a key factor in the success or failure of products. This is also the reason why some shopping supermarkets have been using code scanning and code scanning payment for goods. It is difficult to accurately and intelligently identify who purchased the goods in multi person shopping.

1.3. Research Objectives

In the context of new retail, through the presentation and analysis of the intelligent shopping settlement system solutions of JD intelligent unmanned store, Amazon Go and other intelligent unmanned stores, the comparative analysis objectives of intelligent unmanned store solutions are extracted, and the technical feasibility and technical difficulties are put forward to help retail enterprises avoid the technical risks of intelligent shopping settlement system of intelligent unmanned stores in the new retail field, so as to reduce costs and increase efficiency Improve the return on investment.

This dissertation establishes an evaluation system for the intelligent shopping settlement system of the intelligent unmanned store by means of questionnaire and customer interview, expounds the specific connotation of the constituent elements of the system, develops an evaluation tool for the experience quality of the intelligent shopping settlement system for the consumers of the intelligent unmanned store, and puts forward the design strategy for the customer experience of the intelligent solution of the intelligent unmanned store for the consumers' experience needs, So as to provide direction guidance and content reference for the selection of intelligent shopping system of intelligent unmanned store, and better promote the development of intelligent unmanned store in the new retail field.

In the future, I will elaborate on the following aspects: 1 、 The relevant definitions and development background of artificial intelligence, new retail and intelligent unmanned store; 2 、 Research on the solution of intelligent shopping system of intelligent unmanned store under the new retail background through grounded theory; 3 、 Through the Likert scale, the customer experience evaluation system of intelligent shopping solutions for intelligent unmanned stores is developed under the new retail background; 4 、 Establish the reconstruction strategy of the customer experience evaluation system of intelligent shopping solutions of intelligent unmanned stores under the new retail background; 5 、 Summary and outlook.

1.4. Research Questions

In the context of the new retail, the intelligent shopping solution of intelligent unmanned store has developed to a certain stage, but there are still some questions. The following are the research questions of this dissertation:

RQ1: what are the relevant definitions and development background of AI, new retail and intelligent unmanned store?

RQ2: what is the research progress on intelligent unmanned store and intelligent shopping solutions?

RQ3: what are the factors that affect the intelligent unmanned store intelligent shopping solution for retail enterprises?

RQ4: what is the customer experience evaluation system of intelligent shopping solutions for intelligent unmanned stores based on the Likert scale and under the new retail background?

RQ5: what is the strategy for reconstructing the customer experience evaluation system of intelligent shopping solutions for intelligent unmanned stores under the new retail background through customer evaluation scores?

It is expected that with the development of the research, the above problems can be fully solved.

1.5. Thesis Contributions

This dissertation is based on the research of JD intelligent unmanned store intelligent shopping solutions, and studies the intelligent shopping solutions of intelligent unmanned stores of different retail enterprises. This research has theoretical and practical significance.

1.5.1. Theoretical Significance

1. This study can form a systematic theoretical research foundation for intelligent unmanned store intelligent shopping settlement solutions among different retail enterprises, providing theoretical support for research in this field.

2. The scale of the impact of intelligent shopping settlement solutions on consumer experience among retail enterprises or the new sample of questionnaire survey are established. Therefore, this study can further enrich and improve the retail

10

enterprise research and technology risk avoidance theory of intelligent shopping settlement solutions for intelligent unmanned stores.

1.5.2.   Practical Significance

1. Whether you are a member of the R&D team, a member of the product team, a person in charge of the product or R&D team, or a person in charge of the enterprise, you will investigate the research progress of the company and companies in the same industry on this project at the beginning of the establishment of the enterprise or project. In the field of new retail intelligent unmanned stores, enterprises will understand the relevant research progress when they set up the project, This dissertation will provide different retail enterprises with intelligent shopping solutions in intelligent unmanned stores, which has practical significance for the development direction and planning of unmanned retail enterprises. This dissertation will conduct in-depth research on intelligent unmanned stores, so as to provide guidance for the operation and development of unmanned retail enterprises, provide reference and help for the development of enterprises, and create new impetus for enterprises to obtain competitive advantages.

2. If you are a retailer and need to open a new intelligent unmanned store, this dissertation can provide a set of sorted intelligent unmanned store shopping solutions after customer evaluation for your reference, which has practical significance.

1.6. Dissertation Structure

1.6.1. Research Structure of the Dissertation

The main structure of this dissertation is mainly divided into ten chapters to introduce the intelligent shopping solutions of intelligent unmanned stores under the new retail background. Through the statement and comparison of the intelligent shopping system solutions of intelligent unmanned stores of different retail enterprises and the quantitative analysis of the customer experience evaluation of this solution, the final conclusion is drawn. The specific chapters are as follows:

Chapter 1 – for this study, it discusses the relevant background of intelligent unmanned store and JD intelligent unmanned store under the new retail background, as well as the research problems, research purposes, significance, motivation and structure of the dissertation.

Chapter 2 – for this study, this dissertation discusses the literature review of intelligent unmanned store under the background of new retail, and obtains relevant research progress by reading a large number of existing dissertations, mainly including the literature of new retail, unmanned retail, artificial intelligence, unmanned convenience store, unmanned store, academic journals, online media reports, etc.

Chapter 3 – for this study, the methodology of intelligent unmanned store research under the new retail background is discussed.

Chapter 4 – for this study, it discusses the research on intelligent shopping solutions of intelligent unmanned stores under the new retail background through grounded theory.

Chapter 5 – this study discusses the development of the customer experience evaluation system of intelligent shopping solutions for intelligent unmanned stores under the new retail background through the Likert scale.

Chapter 6 – for this study, it discusses the reconstruction strategies of intelligent shopping solutions for different enterprise intelligent unmanned stores under the new retail background.

Chapter 7 – discusses the main conclusions, limitations and suggestions for future research for this study.

1.6.2. Dissertation Research Process
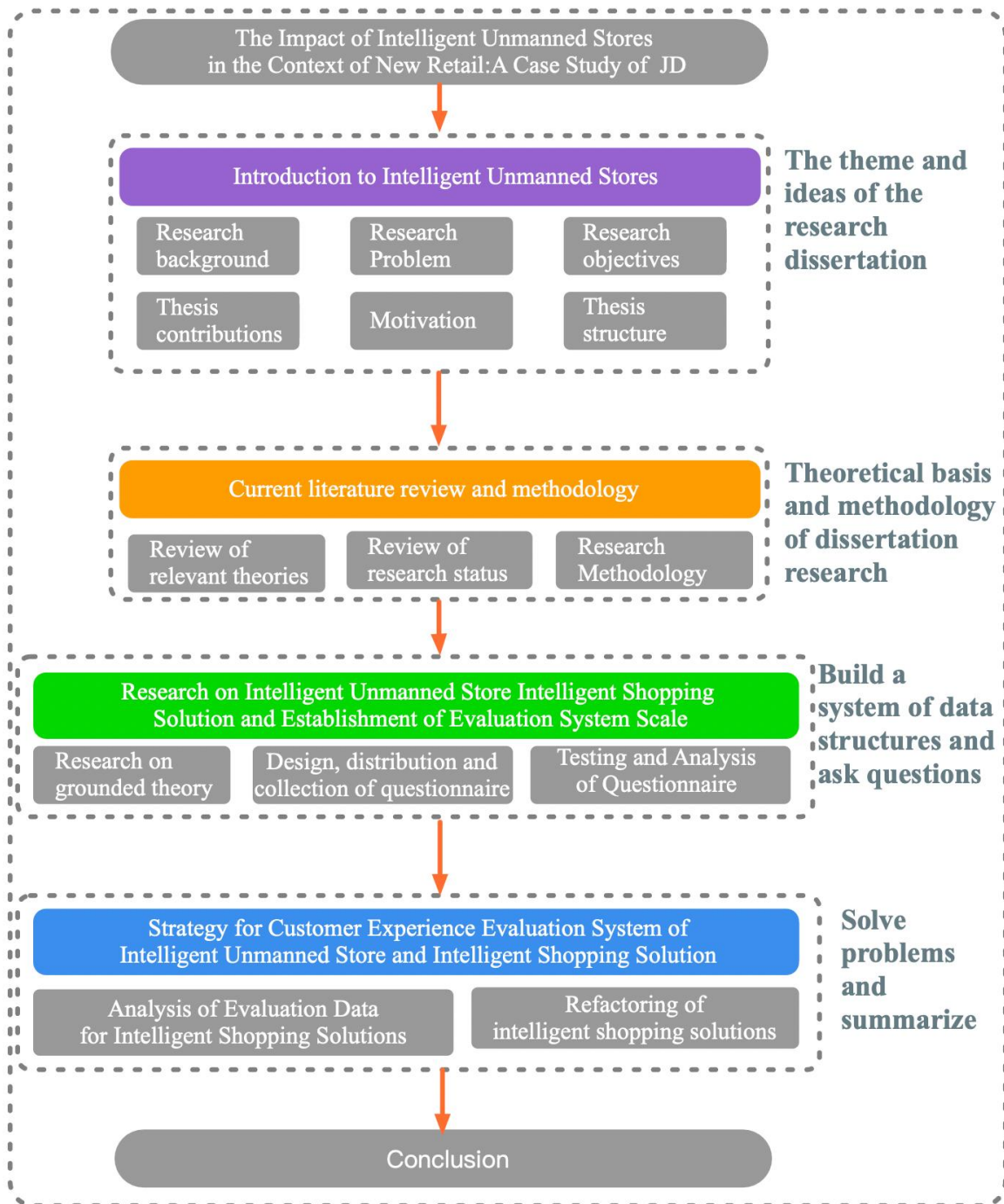
Figure 1.4 Dissertation research flow chart

Chapter 2 – Literature Review

2.1. Overview of Relevant Theories

2.1.1. New Retailing

In October 2016, Alibaba founder Jack Ma first mentioned "new retail" in his speech at the "cloud habitat conference". New retail refers to the combination of offline and online to realize offline store experience, online purchase settlement and offline logistics delivery. Later, it gradually developed into "intelligent retail".

Bill Gates (2017) thinks that "new retail is based on digital technology, through data analysis and intelligent decision-making, so that commodity sales and customer needs can be more accurately matched." the National Retail Federation (2018) thinks that "new retail is the integration of online and offline sales channels and data resources, customer-centric, personalized and diversified shopping experience and services." The World Economic Forum (2018) thinks that: "New retail is to apply scientific and technological innovation to the retail industry to achieve the development goal of Omni channel, intelligent and sustainable development."

Caijing magazine(2017)pointed out that, on July 10, 2017, JD Group CEO Liu Qiangdong mentioned "unbounded retail" in the Fourth Retail Revolution.The article mentioned that the retail industry will usher in the fourth retail revolution in the next 10 to 20 years. What this revolution has changed is not retail, but the infrastructure of retail. The retail infrastructure will become extremely plasticized, intelligent and collaborative, which will promote the arrival of the era of "boundless retail" and realize the upgrading of cost, efficiency and experience.

Baidu Encyclopedia said: "new retailing, in English, is a new retail mode in which enterprises rely on the Internet to upgrade and transform the production, circulation and sales process of goods by using advanced technologies such as big data and artificial intelligence, so as to reshape the business structure and ecosystem, and deeply integrate online services, offline experience and modern logistics."

"Whether it is new retail or unbounded retail, they will eventually develop into intelligent retail. Wen Le media(2023) pointed out that intelligent retail is a

combination of online and offline technologies, which combines AI technology, Internet of things, big data, intelligent tracking and other technologies with shopping scenes, so that consumers can feel the new experience brought by the change of shopping mode by technology. With the development of modern logistics industry, it has solved the pain points of the retail industry in terms of small transportation scale, high cost and long time. The key point of intelligent retail is to combine the Internet with offline physical store terminals, upgrade its mode, and promote the transformation from the era of price consumption to the era of value consumption. "

The essence of new retail is the change of the definition of goods, scenes and participants. Traditional e-commerce is mainly based on production and channels. After the arrival of new retail, it has become consumer-centered, including improving the experience, service and management of consumers. Merchants must have shopping channels, destinations and service systems wherever they want, so as to improve customer experience and realize the purpose of "participant oriented" and "customer is God". The following are definitions of goods, scenarios and participants:

Participants: refers to the people involved in the retail process, including customers, important natural persons involved in the retail process, shopping guides, store managers, distributors, headquarters managers, etc., as well as the internal organizations, decision makers and executives of enterprises engaged in new retail business.

Goods: including goods and services in kind; Including our own goods, other goods, global goods, etc.

Scene: refers to the shopping scene, where all terminals that consumers contact with goods can become "fields", including stores, apps, micro malls, applets, third-party e-commerce platforms, touch screens in stores, intelligent shelves, etc.

2.1.2. Unmanned Retail

Amazon Go, a new concept intelligent unmanned retail store launched by Amazon at the end of 2016, eliminates the need for customers to check out in a long line like shopping in a traditional supermarket, take what they want, walk out of the store, pay instantly, and no clerks participate in the whole shopping process. Therefore, the concept of "unmanned retail" was quickly formed, and this new retail format became popular in China.

IResearch (2017) thinks that unmanned retail stores have the advantages of liberating labor and time costs, and are recognized by major e-commerce platforms and well-known brands. They use machines instead of manual services to reduce the time cost of shipping and purchasing processes, and make services more standardized. Feng(2018) thinks that unmanned retail refers to a new retail service based on intelligent technology without shopping guides and cashiers on duty. Zhu (2019) thinks that Unmanned retail is a part of the transformation from traditional retail to "new retail".Liu(2020) thinks that unmanned retail is a new shopping mode that relies on mobile payment, artificial intelligence, big data and other technologies, integrates online services and offline experience, and aims to improve the shopping experience at the consumer end and the operation efficiency at the enterprise end. At this stage, the main business types of unmanned retail include vending machines, open shelves and unmanned convenience stores. Guo(2020) thinks that unmanned retail includes four basic modes, i.e., unmanned vending machines, unmanned stores, unmanned shelves and unmanned cash registers integrated with traditional retail stores. These four operation modes differ in product richness, unmanned degree and technical content, but fundamentally, they all apply a variety of technologies to reduce costs and facilitate sales through" unmanned . Among these various forms, the model of unmanned store is the most noticeable.

Category of unmanned retail formats:

(1) Vending machine: small footprint, closed type. Typical representatives: Angel orange, Youbao, and order coffee.

(2) Open shelf: small footprint, open type. Typical representatives: Daily excellent fresh convenience purchase, scarlet convenience, etc.

(3) Unmanned convenience store: it covers a large area and has different modes. Typical representatives: jd.com, Bingguo box, convenience bee, etc.

(4) Unmanned Supermarket: it covers a large area and is semi open. Typical representatives: jd.com, TaoCoffee, Amazon Go, etc.

The characteristics of unmanned retail industry are:

(1) Multiple scenes: full time business, covering all kinds of life and work scenes, shortening the distance with consumers and reaching consumers accurately. Scenarios include: communities, subway and other transportation hubs, offices, business districts and other places.

(2) Emphasis on experience: upgrade and transform the traditional retail through technical means, so that the store does not need to queue, and customers can take it and go.

(3) Cost reduction and efficiency improvement: through the structured application of data, we can improve the floor efficiency, optimize the production and supply chain, and realize the efficient circulation of information, funds and goods. Unmanned retail reduces the salary costs of cashiers and shopping guides in retail stores, and the training costs of store managers and clerks.

(4) Intelligent data: collect passenger flow data, commodity data, consumption data, financial data and other data, analyze and apply them to entity operation.

2.1.3. Customer Experience

Customers of intelligent unmanned stores refer to those who use intelligent shopping solutions of intelligent unmanned stores, including consumers, operators, developers, store managers, channel providers, managers, etc.

Baidu Encyclopedia thinks that experience, 1.Refers to personal experience and on-the-spot understanding; 2. Experience gained through personal practice; 3. Inspection.

Customer experience is a purely subjective psychological feeling generated in the process of customers using a certain product or service, while the customer experience of intelligent unattended store refers to the subjective feelings, emotions and unexpected behaviors of customers using intelligent shopping solutions (registration, entering the store, intelligent shopping, intelligent settlement, leaving the store), so as to provide the basis for entrepreneurship, research and development, and operation for enterprises, enterprise R&D personnel, retailers, etc. Customer experience is profit. It gives consumers a positive and efficient experience. They will continue to use your products in the way you guide them. Factors that attract customer experience: usefulness, ease of use, friendliness, and vision.

James and Mick (2004) thought that the antecedents and consequences of creativity in the consumption context were investigated through two experiments. The results show that both situational factors (i.e., time constraints, situational participation) and personal factors (i.e., locus of control, metaphorical thinking

ability) can affect creative consumption, and some of these variables have interactive effects. The results also show that creative action can enhance positive emotions.

2.1.4. Artificial Intelligence Technology

Artificial intelligence (AI) is a technological science, which mainly focuses on research and development, and is used to simulate, extend and expand the methods, theories, technologies and application systems of human intelligence. Artificial intelligence translation is a technology that uses computer linguistics, mathematical logic and formal methods, artificial intelligence and other methods and means, and translates sentences, paragraphs or full text of a natural source language into another natural target language through computer, including linguistics, mathematics, computer science and so on.

Hamet and Tremblay (2017) think that artificial intelligence (AI) is a general term, which means that computers are used to model intelligent behaviors with minimal human intervention. It is generally thought that AI began with the invention of robots. The term comes from the Czech language Robota, which means a biosynthetic machine used for forced labor.

Global market media(2023)think that, the release of consumer centered artificial intelligence (AI) systems such as chatgpt of openai and bard of Google will promote the prosperity for up to ten years, and promote the growth of the generative AI market from US $40billion last year to US $1.3 trillion in 2032.

Global market media(2023)
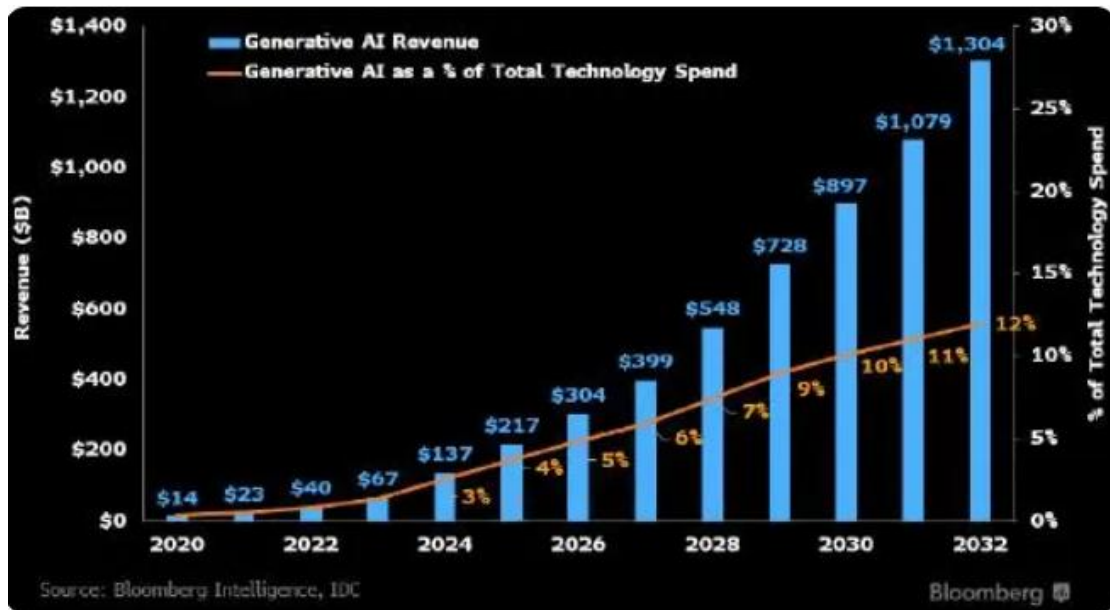
Figure 2.1 AI market financing forecast from 2020 to 2032

Artificial intelligence is a technology that uses computer science to simulate the information process of human consciousness and thinking. The three cornerstones of AI: basic data, computational training, and algorithms. The main technologies include speech recognition, natural language processing, image recognition, biometrics, and machine learning and knowledge mapping.

  1. Machine learning

Batta(2019) said, "machine learning (ML) solves the problem of how to build a computer that automatically improves through experience."

Jordan and Mitchell(2015) said, "machine learning (ML) is a scientific research on Algorithms and statistical models used by computer systems to perform specific tasks without explicit programming.

Machine learning (ML) is to train the model through a large number of data and automatically discover the model in the data. The model will enable the computer to have the ability of learning, judgment and prediction. The more data processed, the more accurate the judgment and prediction ability will be.

The main technologies of machine learning include:

(1) Supervised learning: support vector machine SVM, decision tree, logistic regression, neural network, etc

(2) Unsupervised learning: clustering analysis, dimensionality reduction, etc

(3) Reinforcement learning: Q-learning, deep q-network, etc

Deep learning is a branch of machine learning. It simulates brain neural network through artificial neural network to realize machine autonomous learning.

The main technologies of deep learning include:

(1) Convolutional neural network (CNN): used for image recognition, speech recognition, etc

(2) Recurrent neural network (RNN): used for language model, machine translation, etc

(3) Generative countermeasure network (GAN): used to generate pictures, videos, voice, etc

2. Computer vision

Computer vision technology is mainly used for the understanding and processing of image content. The image analysis task is divided into sub tasks that are easy to manage by using image processing operation and machine learning technology.

The main technologies include:

(1) Image classification: classify images and identify image content

(2) Target detection: detect the target object and position in the image

(3) Semantic segmentation: classify each pixel and understand each part of the image

(4) Motion estimation: estimating and tracking motion trajectories in images

3. Natural language processing

The processing of natural language and the processing of natural language text refers to the ability of computer to process text similar to human beings, which is mainly used to analyze, process and produce natural language, and improve the intelligence of human-computer interaction. The main technologies are:

(1) Part of speech tagging and named entity recognition: classify and label words and phrases

(2) Syntactic analysis: analyzing the syntactic structure of sentences

(3) Machinetranslation: translating one natural language into another

(4) Chat robot: generating conversation replies based on natural language

(5) Large language model (LLM): it is a natural language processing model based on deep learning, which can learn the grammar and semantics of natural language, so as to generate human readable text. Typical large language models:

chatgpt, gpt-4, llama of meta (Facebook), alpaca of Stanford team, vicuna of Berkeley team

4. Intelligent technology

Intelligent robot is a product manufactured by using artificial intelligence technology. With the maturity of algorithms, machine learning and other technologies, intelligent robot products will be more and more applied to human society, such as UAVs, household robots, medical robots and so on.

5. Bio identification technology

Biometric technology refers to a technology that uses human biometrics for identity authentication. It can integrate computer, optics, acoustics, biosensors and biostatistics, and use the inherent biological characteristics of the human body, such as fingerprint, face, iris, vein, voice, gait and so on, for personal identification. It was initially used in judicial identification.

6. Knowledge mapping

Knowledge mapping constructs a structured representation of knowledge through entities and relationships, which can be used for knowledge storage, knowledge reasoning, knowledge question answering, etc.

The main technologies include:

(1) Entity extraction: extract entities from text

(2) Relationship extraction: detect the relationship between entities in text

(3) Knowledge aggregation: integrating entities and relationships into a unified knowledge map

To sum up, AI is widely used in all walks of life, especially in the field of intelligent unmanned stores, such as face image recognition in face recognition, recognition of other people's action tracks in intelligent tracking, product recognition, machine learning, model training, etc.

2.1.5. AIOT Technology

Guo et al.(2021) think that AI Internet of things (AIOT) is a new concept, which aims to perceive, understand and connect" intelligent things "and make the interaction of various networks and systems more efficient. The key step to achieve this goal is to conduct high-precision data analysis at the edge and cloud levels.

Clustering and dimensionality reduction in AIOT can promote efficient data management, storage, calculation and transmission of various data-driven AIOT applications.

Nozari et al.(2022) think that AIOT, which uses the Internet of things to perform intelligent tasks with the help of artificial intelligence integration, is one of these innovations that are expected to transform a complex supply chain into an integration process. Data sensors and RFID (radio detection technology) AIOTand other innovations rely on the power of artificial intelligence analysis to provide information to realize functions such as tracking and instant alarm, so as to improve decision-making. This data can become important information to help improve operations and tasks.

Pise et al.(2022) think that AIOT is composed of three layers: perception, network and application, all of which are vulnerable to security threats. These threats can be aggressive or passive in nature, and they can originate inside and outside the network. Many Internet of things security problems, including replay, sniffing and eavesdropping, will hinder network communication.

AIOT(artificial intelligence internet of things)=AI(Artificial Intelligence)+IOT(Internet of things)

Intelligent Internet of things (AIOT) is the integration of AI technology and IOT technology. The system collects all kinds of information in real time through various sensors, RFID, two-dimensional code and other infrastructure, and intelligently analyzes the data through artificial intelligence algorithms such as machine learning in the terminal device, edge domain or cloud center, including positioning, comparison, prediction, scheduling, etc.

At the technical level, AI enables the Internet of things to acquire the ability of perception and recognition, and the Internet of things provides the data of training algorithm for AI. At the commercial level, they work together in the real economy to promote industrial upgrading and experience optimization. In terms of specific types, there are three major categories: intelligent networking devices with perception/interaction capabilities, equipment asset management through machine learning, and systematic solutions with networking devices and AI capabilities. From the perspective of collaboration, it mainly solves the problems of perception intelligence, analysis intelligence and control/execution intelligence.

5G technology is becoming the landing foundation of AIOT and the technical standard of intelligent city, and is one of the key technologies to support the innovation and prosperity of various industries and enhance the comprehensive national strength.

China Business Intelligence Network(2023) thinks that the revenue scale of the global consumer grade AIoT solution market has increased from $31.8 billion in 2018 to $124.3 billion in 2022, with a compound annual growth rate of 48.8% from 2018 to 2022. It is expected that the market size will reach $158.2 billion in 2023.

The framework of AIOT can be divided into four layers: basic support layer, IOT technology layer, AI technology layer and application layer. The application fields include logistics, transportation, security, energy, medical treatment, construction, home furnishing, retail and agriculture.

The main technologies include: artificial intelligence technology (neural network, mathematical model, BP algorithm, etc.), basic chip, sensor technology, radio frequency identification technology (RFID), two-dimensional code, network communication technology and data analysis and mining technology.

The AIOT hierarchical architecture is as follows:

Elaboration by the author
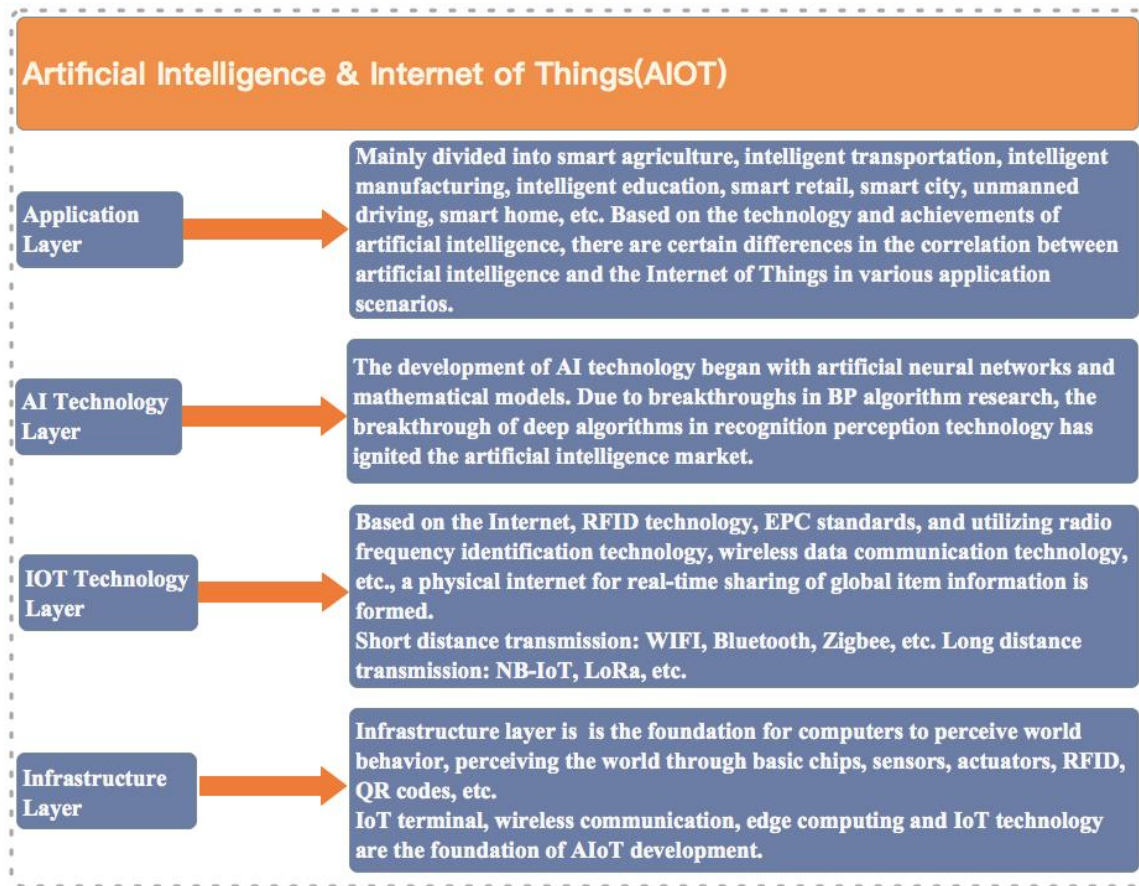
Figure 2.2 AIOT layered architecture diagram

To sum up, AIOT is widely used in intelligent unmanned stores. AIOT technology is the foundation of intelligent unmanned stores. All data collection comes from AIOT.

2.1.6. Mobile Payment Technology

Mobile payment refers to the use of mobile phones, intelligent watches, pads, PDAs, Mobile PCs and other mobile devices to make electronic currency payments for purchased services, digital products, commodities, etc. under financial regulations. Mobile payment effectively combines the Internet, terminal equipment and financial institutions to form a new payment system, and mobile payment can not only make monetary payment, but also pay the cost of living such as telephone, gas, water and electricity. It has time and space constraints and convenient management. It is characterized by high privacy and high comprehensiveness.

The main payment methods of mobile payment include fingerprint payment, face brushing payment, NFC payment (short-range wireless communication payment) and

face brushing payment, mobile online banking payment, sonic payment, public account payment, SMS payment, password payment, vehicle payment, gesture payment, voice payment, etc.

There are five main implementation schemes of mobile payment technology: dual interface CPU card based on 13.56MHz, SIM pass (based on 13.56MHz), rfid-sim (based on 2.4GHz), NFC (based on 13.56MHz) and intelligent SD card [1].

To sum up, face brushing payment, palmprint payment and code scanning payment in mobile payment are widely used in intelligent unmanned stores, which plays an important role in making intelligent and experiential stores more intelligent.

2.1.7. Big Data Technology

Sagiroglu et al.(2013) thinks that big data refers to a massive data set with larger, more diverse and complex structure, which is difficult to store, analyze and visualize to obtain further process or results. The process of studying a large number of data to reveal hidden patterns and secret correlations is called big data analysis. These useful information can help companies or organizations obtain richer and deeper insights and gain advantages in the competition.

Baidu Encyclopedia(2023) thinks that big data, or huge data, refers to information that is too large to be retrieved, managed, processed, and sorted into more active purposes to help enterprises' business decisions within a reasonable time through mainstream software tools.

Big data is usually used together with blockchain. Belotti et al.(2019) think that blockchain is a technology that makes the concept of shared registry of distributed systems a reality in many application fields, from cryptocurrency to any industrial system that may need to make decentralized, robust, credible and automated decisions under the circumstances of multiple stakeholders.

The "2023-2028 China Big Data Industry Market Panorama Assessment and Investment Strategy Planning Research Report" thinks that: "Data is becoming a key force in restructuring global factor resources, reshaping the global economic structure, and changing the global competitive landscape. With the continuous development of information and communication technologies and industries such as the Internet, mobile Internet, the Internet of Things, and 5G, the global data volume

is growing explosively. Benefiting from the rapid growth of data volume and data applications, the global big data market size is growing Kwai. The global big data industry market size will be 64.9 billion in 2021 USD, a year-on-year increase of 13.5%.

The 2023-2028 China Big Data Industry Market Panorama Assessment and Investment Strategy Planning Research Report states: "From a regional distribution perspective, China's data generation accounts for approximately 23% of global data generation, the United States' data generation accounts for approximately 21%, EMEA (Europe, Middle East, Africa) data generation accounts for approximately 30%, and APJxC (Japan and Asia Pacific) data generation accounts for approximately 18%.

Big data has the following characteristics:

(1) Large capacity: the size of data determines the value and potential information of data.

(2) Variety: diversity of data types, including traditional databases, images, files and other complex records

(3) Fast: the logical processing speed of the data through the algorithm is very fast, one second, and high-value information can be quickly obtained from various types of data, which is also essentially different from the traditional data mining technology.

(4) Great value: through the analysis of data, we can know people's hobbies, and then guide the development direction of products. If we have the data of millions of patients nationwide, we can predict the occurrence of diseases based on these data. These are the values of big data.

To sum up, the application of big data runs through the whole field of intelligent unmanned retail. In the process of sales, operation and service in intelligent unmanned stores, it can conduct a comprehensive and multi-dimensional data analysis on customer behavior, shopping preferences and other aspects, so as to improve sales efficiency, optimize service experience and promote revenue growth.

2.1.8.　Summary of This Section

Artificial intelligence, AIOT, mobile payment, big data and other technologies are the key technologies used in the intelligent unmanned store. It is these technologies that make it possible for the intelligent shopping of the intelligent unmanned store without the participation of clerks in the whole process. This chapter lists the concepts of key software and hardware technologies and related theories used in the shopping process of intelligent unmanned stores, such as entering stores, intelligent shopping, intelligent settlement, leaving stores, attracting customers, data analysis, etc., which paves the way for the subsequent research of this dissertation.

2.2. Overview of Research Status

2.2.1. Current Research Status Abroad

2.2.1.1. Research Status of Intelligent Unmanned Stores Abroad

From the perspective of sustainability, Denuwara1 et al.(2021) thought that through the critical analysis of the impact of the sustainability of unmanned stores and the evaluation of the strategic direction and growth strategy of major companies and organizations in the value chain, the results showed that grocery stores were the current expansion target. The expectations of business developers for the future mainly tend to come from founders and books. The investment logic of participants' expected returns is biased towards effectiveness, and the value chain benefits mainly come from the use of big data and data analysis. The most important use of data relates to dynamic pricing models.

From the perspective of customer experience, Jewon et al.(2021) think that through empirical research, perceived enjoyment has a greater impact on hedonistic value and economic value in unmanned stores, and perceived enjoyment has a positive impact on customer revisit in unmanned stores, while perceived usefulness only has a greater impact on functional value. Lee et al.(2021) think that through the comprehensive use of qualitative and quantitative research methods, it is concluded that the attributes of the service scene of the unmanned store have four aspects: personalization, accessibility, instantaneity and openness. Among them, instantaneity has the greatest impact on customer attitudes, followed by openness, but

personalization and accessibility have no significant impact. Wang et al.(2021) thought that through the research and analysis of the impact of the marketing mix factors of the unmanned store on customer experience and satisfaction, they pointed out that price had no significant impact on consumers' sensory experience and emotional experience, while factors such as promotion, distribution and products had a significant positive impact on consumers' experience, while relationship experience, emotional experience and sensory experience had a positive impact on satisfaction, Based on this, it is proposed that the shopping experience can be enhanced by providing Scenario Oriented, personalized and experience based services to customers, so as to improve customer satisfaction.

From a strategic perspective, leekwangkeun, Jeon (2018) thought that 7-Eleven, the Japanese convenience store industry, was selected as a representative case study to analyze the specific competitive advantage strategy formulated by 7-Eleven according to the changes in the Japanese convenience store industry. The study found that five competitive strategic factors, including the leading strategy, the innovative logistics system strategy, the information system development strategy, the joint product development strategy and the direct communication strategy, were closely related to each other, forming a combined strategy with the franchise development strategy as the core. 7-Eleven's competitive advantage is considered to be through the complementary combination of five competitive strategies to achieve rapid response to change, cost advantage and differentiation advantage. Jung Hwa SEO et al. (2018) thought that they could understand the development of unattended convenience stores by investigating the current operation systems of convenience stores and competitive retail stores. Through the field survey of three ordinary convenience stores, three unattended convenience stores and three retailers, it is concluded that unattended convenience stores save operating costs, reduce labor, provide convenient and comfortable shopping experience for tourists, and effectively use resources. Through further research of quantitative analysis, find out the strategic conditions for the promotion of unattended convenience stores.

From the perspective of technology, Esther and Kristyo (2019) thinks that through research and analysis of the factors affecting customers' willingness to use the technology of Indonesia's unmanned stores, The management of JD.ID X can improve their implementation of unmanned store technology. In this study, a

questionnaire was distributed to 100 respondents using quantitative method. After obtaining the data of the respondents, IBM SPSS 23 was used to analyze the data. From the results of this study, variable performance expectations (PE), social impact (SI), convenience (FC) and store reputation (SR) are positively correlated with use intention (IU). At the same time, variable effort expectation (EE) is not positively correlated with intention to use (IU).

2.2.1.2. Research status of intelligent shopping solutions abroad

NVIDIA China (2021) thinks that "zippin" is an automatic checkout unmanned store selling food and drinks, and people can enjoy the shopping experience of "take it and go". "Zippin" relies on NVIDIA Jetson AI platform to conduct model reasoning at the speed of 30 frames per second, and can process customers' purchase in real time. The processing speed of the app is fast enough to help the store entertain a large number of customers at the same time. Secondly, the convolutional neural network is used for product recognition and store location in order to track customers' purchase behavior. In addition, through zippin's retail application, the intelligent shelf in the unmanned store can determine whether the products on the shelf are removed or replaced. NVIDIA edge AI driven platform can process shelf data and video data in parallel, and combine with sensor fusion technology to quickly determine which customer took which product. The platform can deploy two of the three sensors (vision, weight and position) and rely on them to operate effectively. It can identify all kinds of goods in real time, and continuously improve the system through training in the deployment process. Because zippin platform can track products, it can help unmanned stores realize inventory management automation and bring more benefits to stores.

Liu(2017) thinks that when shopping in traditional supermarkets, the process is generally "enter from the entrance of the supermarket → buy goods → queue up for settlement → change → exit". At the peak of shopping season, queuing for settlement takes up too much time for customers. Amazon Go alleviates this pain point, which can realize buy and go without queuing for settlement. The core of Amazon Go technology is the seamless combination of sensor recognition system and online payment. Customers can get the QR code by registering on Amazon Go

app, then scan the code to enter the store, purchase goods after entering the store, settle accounts automatically, and leave the store. In the process of customer intelligent shopping, a large number of intelligent technologies are used, such as AIOT, deep learning, neural network, intelligent payment, biometrics, image recognition, face recognition, big data analysis and other technologies.

Zeng(2017) thinks that "Amazon Go" needs to download the app, scan the code to enter the door, calculate the effective shopping behavior and identify the goods through face recognition and multi-sensor (RFID, pressure sensing, audio recognition, visual recognition). The recognition accuracy is high, but too many people in the system will cause failures, and due to the limitations of RFID and laminate, the distance between goods will affect the accuracy of tracking.

Planet (2017) thinks that in 2016, Amazon Go unmanned convenience store opened at Amazon headquarters, triggering a frenzy of discussion on the "unmanned store" model in the retail industry. Amazon Go is designed to improve customers' shopping experience and pay for "free shopping" mode without queuing. It does not limit the number of people in the store, and does not need to go through the payment channel or scan the code for shopping. It really realizes taking it and leaving. Due to the complexity of technology. When more than 20 people enter the venue, or two people close to each other take goods at the same time, Amazon Go cannot accurately match. Amazon claims to be 99.9% accurate at present, but Amazon hopes to reach 99.999%. In addition, the R&D and landing costs of Amazon Go are particularly high. They actually visited Amazon Go in Seattle and estimated the cost of its single store at about 5million yuan. They speculate that the reason for the delay is that it is difficult to make profits and copy with high investment.

From the Internet

Figure 2.3 Amazon Go unmanned convenience store

2.2.2. Current Research Status in China

2.2.2.1. Research Status of Intelligent Unmanned Stores in China

From the perspective of customer experience, Hsu et al.(2019) thinks that the development goal of the 7-11 unmanned store x-store is exploration, experience and excellence. This dissertation mainly investigates the experience evaluation of unmanned stores from the three dimensions of economic experience, marketing experience and quality experience, and finds that "performance expectation", "effort expectation", social impact, convenience, behavior intention and use behavior will affect consumers' intention of unmanned stores. Lo and Wang (2019) thinks that by studying the customer experience process of x-store, we can determine the relationship between customers and the interaction between tangible and intangible objects, as well as the reasons behind the lack of bad customer experience. The elements corresponding to higher customer scores include entertainment environment, positive sensory experience and innovative products or facilities. The most representative factors of these elements include interactive wine cabinet, futuristic layout and facial recognition. In contrast, factors with low satisfaction include being away from the noisy environment, the experience of being introduced with new ideas (thoughts) and facilities that are easy to operate. The most representative factors behind these elements include the inability to conduct immersive shopping, the lack of memory of limited edition souvenirs, and the poor use of applications. Wu (2019) and others think that through the analysis of the experience quality of consumers in a bingo box shopping in Shanghai, to better understand the impact of relationship on their perceived experience psychological state and experience results in the retail industry, the results will help retail management formulate and implement self-service strategies to improve the experience quality and experience psychological state, so as to improve consumers' perception of experience results.

Zou(2020) thinks that: from the perspective of availability theory, combined with the characteristics of the experience of unmanned retail stores, extract and reconstruct the experience availability elements and their correlation mechanism that can help optimize the shopping experience of consumers in unmanned retail stores. The overall perception of the customer experience of unmanned retail stores in the

32

past has been transformed into concrete content that can be systematically analyzed, providing a possible guidance path for design practice. This dissertation selects the unmanned retail store driven by the Internet of things technology as the research object, and focuses on the systematic and specific discussion of the shopping experience from the three dimensions of the physical environment, shopping use process and consumers' emotional cognitive feedback of the unmanned retail store. Hu(2022) thinks that through qualitative research and quantitative analysis methods such as grounded theory, factor analysis, questionnaire survey and customer interview, the content, evaluation methods, customer experience problems and solutions of the customer experience evaluation system of community unattended stores are answered. Through research and analysis: firstly, the customer experience evaluation system of community unmanned stores was obtained, including five macro experience dimensions, "convenience, affordability, security, comfort and friendliness", ten micro levels, "timely service, smooth transaction, preferential price, good quality, environmental security, payment security, information security, space comfort, interactive comfort, and friendly image", and 48 sub indicators of its subordinates. Secondly, the research obtained the standardized community unmanned store customer experience evaluation scale verified by data, including 9 dimensions and 36 specific items of "timely service, smooth transaction, preferential price, good quality, environmental safety, payment safety, space comfort, interactive comfort and friendly image". Finally, the main experience problems and the causes of the problems faced by the widely used "interrupted and separated" community unmanned stores in China are obtained, and further cluster analysis is made on the problems.

From the perspective of cost control, Sun et al.(2022) thinks that under the background of "new retail", the unmanned convenience stores still need to deal with the challenges in operation, including the difficulty of landing and site selection, immature technology and low public awareness. The important problem is the supply chain cost control. This dissertation calculates and analyzes the supply chain cost of the unmanned convenience stores through cost analysis methods such as flexible budget method, and puts forward cost control methods from the perspective of supply chain management.

From the perspective of business model, Zhong and Zhang(2021) thought that: from the perspective of meeting consumer demand, enterprise product supply and

enterprise profit contribution, this dissertation analyzed the innovation contribution of unmanned convenience stores in the catering business model, and refined its shortcomings and difficulties, so as to provide theoretical support and reference for the business model innovation of today's catering industry. Liu(2020) thought that: through the research in strict accordance with the standard process of grounded theory, five innovation paths of unmanned retail business model were obtained, and the business model innovation paths of new retail represented by unmanned retail were analyzed from the perspectives of innovative business logic, innovative marketing strategy, innovative operation mode, broadening the dimension of value acquisition and innovative value network. The following is a detailed description of five innovation paths of unmanned retail business model:

(1) Analysis of innovative business logic: balancing experience and efficiency, cost and profit will become the value proposition of new retail in the future. It is required to put operation service efficiency and profitability into an equally important position in business logic on the basis of the balance between past experience and cost, so as to more efficiently transform customer experience into higher economic benefits. (2) Analysis of innovative marketing strategy: the essence of the innovation of the new retail marketing strategy is to learn from the recursive thinking of unattended retail close to customers, subvert the funnel mode of e-commerce that completely depends on traffic and conversion rate, but monopolize the offline consumption scene of consumers, and then obtain customers. (3) Innovative operation mode: the innovative operation mode requires fast shopping process, complete goods, scene optimization and more attention to scene innovation. (4) Broaden the dimension of value acquisition: the first aspect of broadening value acquisition is cost.(5) Innovation value network: the essence of innovation value network is to redefine the position, partnership and cooperation mode of enterprises in the value network. Zhou Jie (2023) thought that through the research on TJ convenience store, one of the leading enterprises of Shanxi local convenience stores, using 4P theory and STP marketing strategy, questionnaire survey, field interview and other methods, it was found that TJ convenience store had some problems, such as serious commodity homogeneity, relatively high commodity pricing, single form of promotion activities, slow development of O2O mode and so on. Find out that TJ convenience stores ignore customer needs and have vague differentiated positioning;

Low degree of data and weak scientific pricing mechanism; Lack of promotion strategies and poor digital marketing; The logistics capacity is insufficient, and the degree of online integration is low. Based on this, four optimization measures and two safeguard measures are put forward, including humanized differential selection, scientific pricing of big data, diversified promotion strategies, and collaborative development of OMO channels.

2.2.2.2. Research status of intelligent shopping solutions in China

Lu and Gao (2021) thought that by designing an intelligent container for unattended retail shopping, unattended technology was combined with the container. Through two-dimensional code, electronic anti-theft, RFID and other technologies, design and realize all the data of goods taken away during the shopping process. The use of unattended technology provides consumers with authentication, automatic settlement, self-service payment and other services, so that consumers can enjoy high-quality and fast consumption experience without going through the manual service of merchants. At the same time, the new intelligent unmanned retail shopping container can be deployed closer to consumers, which greatly improves the current situation of community shopping, significantly improves the commercial efficiency of unmanned retail, and effectively improves the re purchase rate of goods.

The new intelligent unmanned retail shopping container is 6 meters long, 3 meters wide, 2.9 meters high, weighs less than 4 tons, and covers an area of about 18 square meters. The new intelligent unmanned retail shopping container mainly uses four key technologies: access control system, RFID Internet of things, automatic settlement and intelligent monitoring. In terms of structure, the shopping container adopts the design of separation of entrance and exit, and separation of shopping area and settlement area. The overall design effect of the new intelligent unmanned retail shopping container is shown in the following figure.

Lu and Gao (2021)
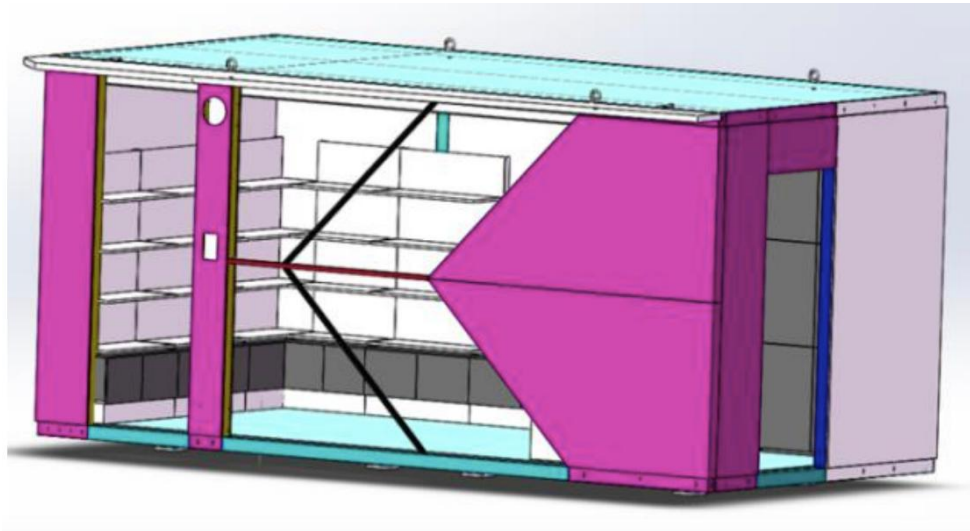
Figure 2.4 New Intelligent Unmanned Retail Shopping Container

Shenzhou franchise network (2019) and fastcat official account (2017) publicize Takego AI self-service counter: the take go unmanned intelligent shopping system is independently developed by Shenlan technology and applies the most cutting-edge technologies in the field of artificial intelligence, such as artificial intelligence convolutional neural network, deep learning, machine vision, biometric recognition, biological payment and so on. It fully realizes the full intelligent operation of the unmanned store, including sweeping into the store, shopping directly, taking it and leaving without checking out, There is no payment link in the whole process. Shopping is as convenient as taking things at home.

Takego AI self selling counter is mainly used to generate encrypted characters by using the capillary lines of customers' palms. This character can be bound with customers' information. Customers can register their palmprint once and use it for life by "sweeping their hands to open the door". Customers also need to bind their mobile phone scanning code to Alipay or wechat secret free payment, which can make intelligent payment faster. Customers scan their palms to open the door and select goods. The system records consumer behavior information. Artificial intelligence algorithm and big data match to determine the price of goods. When the customer takes away the goods and closes the door, the system Alipay or wechat secret free payment will automatically complete the payment.

Takego uses computer vision technology to identify goods, so it has no restrictions on the categories of goods on the shelves, and it does not need to label the goods before they are on the shelves. If you want to put a new product on the shelf, you only need to learn the "teach" system visual information to identify the product in the background machine. Mobile payment, unattended sales and code scanning settlement, these cashless payment and settlement have

just begun to change consumers' shopping experience. This is the application scenario of Takego, an unmanned intelligent retail product.

The Takego super convenient AI self selling counter relies on the quixmart fast CAT system to realize 24-hour timely inventory and early warning. It is convenient for the shopkeeper to easily master the inventory even if he travels, and arrange replenishment in time.

Lu and Gao (2021)

Figure 2.5 TakeGo AI self-service counter

Liu(2020) thinks that data is the basis of technological innovation, and technology is the key to affecting the specific behavior characteristics of unmanned retail stores. The unmanned retail stores are divided into three categories: unmanned retail stores based on AI Artificial intelligence system, unmanned retail stores based on physical network technology and unmanned retail stores based on Internet technology system. The behavior patterns in unmanned retail stores are divided into three types: full self-service procurement, which uses artificial intelligence technology to capture through biometrics and video capture. People have a higher degree of freedom of behavior in the store and can meet the diversified consumption experience of customers; Unattended self settlement, which mainly adopts technologies including Internet of things system and RFID radio frequency identification. People's activities in the store are limited by technology and space, but it can basically realize convenient shopping for customers in the unattended situation; The third category is the emerging convenience based on Internet technology. Its advantages lie in the supply channel and technology cost, but it can identify the barcode and payment code of goods through app goods to meet the basic operation experience of daily shopping. Take Amazon Go unmanned store, Suning Tesco BIU unmanned store and F5 future store as three typical cases based on different technology forms. Amazon Go unmanned store adopts a case based on Artificial intelligence system, which is described in detail in the following chapters. Suning Tesco BIU

unmanned store is a case based on the Internet of things technology system. When entering the store, open Suning Tesco BIU app, register and obtain coupons and other operations. The registered person directly scans the code to enter the store or face recognition to enter the store. When shopping normally, he enters the payment area, places the goods in the designated area, automatically identifies the quantity and price of goods, scans the code for payment, and leaves the store after payment. F5 future store is a case based on Internet technology. After entering the store, new customers register with the app, old customers scan the code directly for shopping, pay directly in the payment area, pick up goods in the picking area, pack or eat in the store, and finally leave the store. This dissertation mainly analyzes the availability of unmanned retail stores driven by the Internet of things, and does not study the customer experience of unmanned stores driven by other technologies.

Zhang(2021) thinks that through the design based on Amazon Go system, the system architecture of visual capture and tracking in the scene of unmanned store is realized. This architecture is divided into four parts: taking and putting back judgment, commodity type identification, establishing the relationship between commodities and people, and identifying people's identity. The functions of these four parts are developed, and the visual capture and tracking system in the scene of the unmanned store is tested from two aspects of function and performance. The test results show that 10 frames of video can be processed in one second. For single person shopping, the identification is basically accurate. For each module, taking and putting back judgment can detect all the actions of customers' raising their hands. Sometimes customers just reach out and do not operate the goods, which is prone to misjudgment. Face recognition is also correct, but if all cameras do not capture human face images, the results of face recognition will not be obtained. If there is occlusion between multiple people, recognition errors will occur. The main factor affecting the accuracy of the system is the identification of commodity types, mainly because it is difficult to determine the size of cut commodities. When there is little difference in color and shape between commodities, it is easy to misjudge.

Yang(2022) thinks that by studying the 3D positioning of pedestrians under multi camera based on computer vision, in the application of unmanned stores based on sensor fusion, it is necessary to obtain the 3D coordinates of customers and calculate the distance from the 3D coordinates of goods, so as to associate goods with customers and get the shopping list of customers. The pedestrian positioning system with multi camera is divided into three modules, namely, target detection and tracking module, cross view target association module Pedestrian

3D positioning and trajectory continuous processing module. The test shows that each module meets the requirements and achieves high accuracy.

2.2.2.3. Summary of domestic and foreign research reviews

To sum up, foreign research on intelligent unmanned stores mainly elaborates the follow-up development goals from the perspective of sustainability. From the perspective of customer experience, perceived enjoyment has a greater impact on hedonistic value and economic value, the attributes of service scenarios are personalized, accessible, instant and open, and the impact of marketing mix factors on customer experience and satisfaction. From a strategic perspective, it is found that the five competitive strategic factors, namely, the leading strategy, the innovative logistics system strategy, the information system development strategy, the joint product development strategy and the direct communication strategy, are closely related to each other. From the perspective of technology, variable performance expectation (PE), social impact (SI), convenience (FC) and store reputation (SR) are positively correlated with use intention (IU). There was no positive correlation between EE and IU.

Foreign intelligent shopping solutions are mainly represented by Amazon Go of Amazon and zinpin of NVIDIA, which study the Amazon Go unmanned convenience store, zinpin intelligent shopping system and shopping process.

The domestic research on intelligent unmanned stores mainly focuses on customer experience, including economic experience, marketing experience and quality experience, the impact of perceived experience psychological state and experience results in the retail industry, as well as grounded theory and availability. Secondly, from the cost control, business model and other aspects.

The domestic intelligent shopping solutions mainly choose two representative intelligent solutions, one is an intelligent unmanned retail shopping container and the other is Shenlan technology's take go AI self-selling container. In the field of selling containers, they are very mature solutions. Because they belong to the category of unmanned retail, AI and other related technologies applied in selling containers can also be applied to intelligent unmanned supermarkets and intelligent unmanned convenience stores. Of course, there are also many mature shopping solutions for

intelligent unmanned stores in China, such as TaoCoffee, JD intelligent unmanned supermarket, JD intelligent unmanned convenience store, F5 future store, HEMA unmanned store, 7fresh unmanned convenience store, etc. the following chapters of this dissertation will discuss the intelligent shopping solutions for representative intelligent unmanned stores.

Chapter 3 – Methodology

3.1. Literature Research

Through collecting and analyzing patents, journal literature, academic works, network media reports, network news, etc. published by researchers in the field of intelligent shopping solutions for intelligent unmanned stores on Google academic, CNKI, Wanfang Data and other websites at home and abroad, we can comprehensively understand the latest research status and progress of intelligent shopping solutions for intelligent unmanned stores at home and abroad, form a scientific and systematic understanding of the user experience of intelligent shopping solutions for intelligent unmanned stores, and clarify the value direction of research and specific research issues.

3.2. Grounded Theory

Grounded theory was proposed by Barney and Anselm(2017) in the book "he discovery of grounded theory: strategies for qualitative research". It is a qualitative and bottom-up research method, which is mainly based on empirical data. Researchers do not have theoretical assumptions before research, but directly start from actual observation, summarize experience from original data, and then rise to theory.

Grounded theory three-level coding:

1. Open coding: the process of naming and categorizing the contents of the original data and the re combination of the original data.

2. Axial coding: it is mainly to discover and establish various organic links between the main concept category and the secondary concept category.

3. Selective coding: select a "core category" after systematic analysis among all conceptual categories, which is inclusive and general.

The flow chart of grounded theory research is as follows:
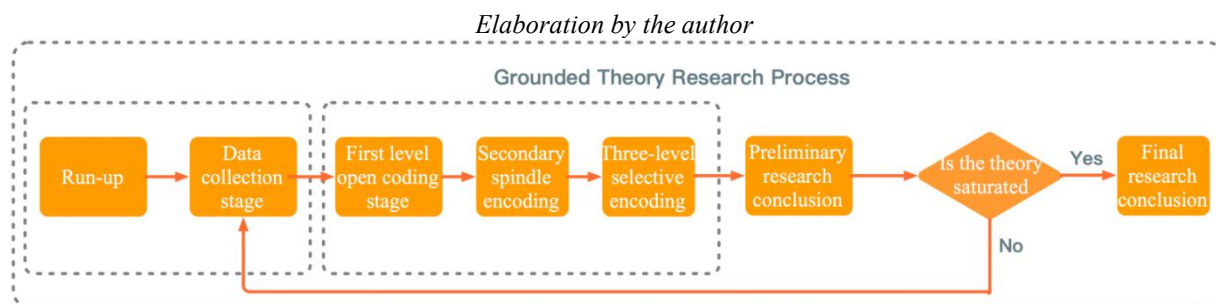
Figure 3.1 Grounded theory research flow chart

The process steps of grounded theory research are described as follows:

1. Preparatory stage: clarify the research issues, objectives and scope, collect relevant literature and background data, and formulate the research plan and schedule.

2. Data collection stage: collect relevant data through different data collection methods, such as interview, observation, text analysis, etc., and establish a database to preliminarily classify and code the data.

3. First level open coding stage: the preliminary coding is thoroughly explained and analyzed to identify potential patterns and themes in the data. Through repeated inspection and comparison of data, different latitudes and levels of data are found to form a preliminary conceptual classification.

4. Secondary spindle coding stage: on the basis of open coding, further sorting and refining concept classification, transforming it into theoretical categories and patterns, discovering the correlation and dependence between concepts, and forming a preliminary theory.

5. Three level selective coding stage: Test and verify the preliminary theory, conduct empirical research, verify the effectiveness and applicability of the theory, and further refine and revise the theory.

Establish preliminary research theory: establish preliminary research theory through three-level selective coding to check whether the theory is saturated. If it is saturated, it can form the final theoretical research. Otherwise, return to the stage of collecting data and repeat for many times.

This dissertation systematically analyzes the original data through grounded theory, this dissertation systematically analyzes the original data, abstracts the concept, sub category definition and main category definition, and then obtains the preliminary research theory, and finally forms the final research theory in the case of concept saturation. This dissertation mainly uses media interviews, media reports,

papers, journals, etc. as the original data. Through the analysis of the original data, it concludes the main factors that affect the customer experience of intelligent shopping solutions for retail enterprises' intelligent unmanned stores, so as to prepare for the construction of a set of intelligent shopping solutions with high efficiency, high recognition rate and good experience.

3.3. Interviews

Through interviews with R&D personnel or manager or high-quality people, the research objects were interviewed to obtain their first-hand behavior information, subjective feelings and future expectations of using intelligent shopping solutions in intelligent unmanned stores, and to explore the pain points and expectations of customers using intelligent shopping solutions in intelligent unmanned stores, Thus, it serves as an important basis for the construction of the customer experience framework of intelligent shopping solutions for intelligent unmanned stores and the main source of data for the customer experience problems of intelligent shopping solutions for intelligent unmanned stores.

3.4. Questionnaire Surveys

The basic situation of customers' experience of intelligent shopping solutions in intelligent unmanned stores is investigated in batches through uniformly designed questionnaires. This study mainly conducted two surveys. The first survey was designed according to the customer experience framework of intelligent shopping solutions of intelligent unmanned stores. Its purpose was to extract the customer experience evaluation scale of intelligent shopping solutions of intelligent unmanned stores(testing the correctness of the scale). The second survey is to use the refined customer experience evaluation scale of intelligent shopping solutions for intelligent unmanned stores to evaluate the customer experience quality of intelligent shopping solutions for intelligent unmanned stores to get the main problems they face.

3.5. Statistic Analysis

Based on the theory and method of statistical analysis, this dissertation uses data statistical analysis software (SPSS, Amos) to carry out descriptive analysis, item

analysis and factor analysis on the data collected from the customer experience quality evaluation questionnaire of intelligent shopping solutions for intelligent unmanned stores. The purpose is to test the hypothesis of the correlation and causal relationship between variables in the theoretical framework, so as to improve the evaluation model and evaluation system.

Chapter 4 – Research Based on Grounded Theory

4.1. Preliminary Stage

The preparatory stage is mainly to clarify the research issues, objectives and scope, and collect relevant literature and background data. From the content of the first chapter, we can know that part of the goal of this dissertation is to study the intelligent shopping solutions of different retail enterprises' intelligent unmanned stores, and then find out the factors that affect the customer experience at each node in the whole shopping process of customers' entering the store, intelligent shopping, intelligent settlement and leaving the store through grounded theory. According to these factors, we conduct a survey, get the design with good customer evaluation and high score on each node, and then reorganize the design scheme to form a set of intelligent shopping solutions more suitable for retail enterprises, members of R&D departments, members of product departments, heads of enterprises, etc. If we want to achieve this goal, we need to find out the factors that affect the customer experience of intelligent shopping solutions in intelligent unmanned stores of different retail enterprises through grounded theory and abstract concepts, and then conduct coupon surveys or interviews on these factors, and get the final results through analysis. After understanding our goal of using grounded theory, we will start the steps of data collection and collation.

4.2. Sample Data Collection and Collation

Sample data collection and collation is to collect relevant data through different data collection methods, establish data relationship table structure, and preliminarily classify and code the data. Since the development of new retail in 2016, although many intelligent unmanned stores have been opened all over the world, most customers do not pay attention to the operation and technical support behind the intelligent unmanned stores when shopping. Therefore, when preparing the sample data, there are certain requirements for the interviewees. The interviewees are generally high-quality people or members of the R&D team and the person in charge or the person in charge of the enterprise. In the process of preparing the sample data,

it is basically obtained through personal interviews and media interviews, as well as papers, journals, personal we media and other ways to obtain samples, which has greatly improved the reliability and validity.

The sample data of intelligent shopping solutions for retail enterprises' intelligent unmanned stores are mainly obtained from media interviews, media reports, journals, papers and patents, including 9 sample data of media interviews and reports of jd.com intelligent unmanned convenience stores; 7 sample data of media interviews and reports of JD intelligent x unmanned supermarket and 1 sample data of journals; Six sample data of media interviews and reports of Alibaba's "TaoCoffee" intelligent unmanned supermarket, and three sample data of journals; There are 3 sample data of Amazon Go academic papers, 4 sample data of journals, 6 sample data of media interviews and reports, and 2 sample data of personal we media, a total of 41 sample data. Since the content of this dissertation is under the new retail background, which starts from 2016, the sample data is from 2016 to 2023. In these data, patents, interviews and papers of some enterprises' intelligent shopping solutions for intelligent unmanned stores may be around 2017, but they will not affect the use, because so far no revolutionary innovative technology has been produced, and all of them have advantages and disadvantages, which will be described in detail in the following chapters.

The number of sample data sources cited in this dissertation is as follows:

Elaboration by the author

Table 4.1 Statistics of partial sample data sources

Company Name	Intelligent unmanned store	Classification	Number
JD.com	Intelligent Unmanned convenience store	Media interviews and reports	9
JD.com	JD intelligent X Unmanned Supermarket	Media interviews and reports	7
JD.com	JD intelligent X Unmanned Supermarket	Journal	1
Alibaba	Taobao Coffee Unmanned Supermarket	Journal	3
Alibaba	Taobao Coffee Unmanned Supermarket	Media interviews and reports	6
Amazon	Amazon Go	Academic dissertations	3
Amazon	Amazon Go	Journal	4

Amazon	Amazon Go	Media interviews and reports	6
Amazon	Amazon Go	Personal self media	2

The sample data in the following table is mainly the sample data obtained from interviews with department heads or product heads of the R&D Department of intelligent shopping solutions for retail enterprises' intelligent unmanned stores, as well as the sample data of journals, papers and so on. Some specific sample data are shown in the table below:

Elaboration by the author

Table 4.2 Partial sample data sources

Company Name	Classification	Name	Authors	References
JD Unmanned convenience store				
JD.com	Media interviews and reports	JD Convenience Store Launches New Unmanned Retail Solution D-Mart	Interviewee: Department head, Mou Guangsen	Mou(2023)
	Media interviews and reports	No longer high cost and conceptualized, JD has opened a more "affordable" unmanned convenience store	Interviewee: Chen Yu, Head of Business Unit	Xie(2017)
	Media interviews and reports	The upcoming unmanned convenience stores and supermarkets conceal these seven black technologies	Editor in charge: Zhang Yanni	Zhang(2017)
JDX Unmanned Supermarket				
JD.com	Journal	Exploration of the Current Situation and Development Trends of Unmanned Supermarkets: Taking "JDX" in Wuhan as an Example	Zhang Xu; Bao Qinwen; Xu Jiajing	Zhang et al.(2017)
	Media interviews and reports	JDX Unmanned Supermarket's first socialized store is expected to be profitable within three to five months of opening	Interviewee: Song Peng	Song(2023)
	Media interviews and reports	The first JDX unmanned supermarket in Chengdu has landed in the high-tech zone, and the fastest settlement time for facial recognition is only 5 seconds	He Gu	He(2017)
"Tao Coffee" Unmanned Supermarket				
Alibaba	Journal	Unmanned Store: A Practical Sample of "New Retail"	Zhao Zheng	Zhao(2017)

	Media interviews and reports	Unmanned Store: "New Retail" Practice Sample "Tao Coffee" Appears on Tmall's New Retail with Distinctive Gaming	Wang Xuquan	Wang(2017)
	Journal	Research on the Innovation Transformation of Physical "New Retail" under the Background of Artificial Intelligence	Zhang Yuanyuan	Zhang(2019)
	Journal	Artificial intelligence drives the rise of unmanned retail	Zeng Xiangyun	Zeng(2017)
Amazon Go				
Amazon	Academic dissertations	Research and Implementation of Visual Capture and Tracking Technology in the Scene of Unmanned Stores	Zhang Qianqian	Zhang(2021)
	Journal	Taking "Amazon Go" as an example to discuss the impact of artificial intelligence on the retail industry	Zhang Zeji	Zhang(2017)
	Media interviews and reports	Deep	Detailed Explanation of AmazomGo's Three Core Technologies	Lei Feng Network	Lei(2017)
	Academic dissertations	Research on Customer Experience Design of Unmanned Stores in the Context of Community-based New Retail	Hu Weizhuan	Hu(2022)

The following is a list of personal interview questions. The content of this list is based on the dissertation of Zou(2020) and Hu(2022) . The specific contents are described in the table below:

Elaboration by the author

Table 4.3 Personal interview questions

Type	Contents	References
Basic information	Name, gender, occupation, educational background Have you ever used any intelligent unmanned stores? (JD Intelligent Unmanned Convenience Store、 JDX Intelligent Unmanned Supermarket,、 TaoCoffee Intelligent Unmanned Store,、 Amazon Go Unmanned Convenience Store、 other)	Zou(2020),Hu(2022)
Experience and Impression	What was your first motivation to use a intelligent unmanned store? Can you describe the process of entering an intelligent unmanned store? Can you describe the process of shopping in an intelligent unmanned store? Can you describe the process of settlement in an intelligent unmanned store? Can you describe the process of leaving the intelligent unmanned store? Do you encounter any problems in the intelligent unmanned store? How was it resolved?	Zou(2020),Hu(2022)

Open Question	How was your entire shopping process at the intelligent unmanned store? Do you have any further suggestions?	Zou(2020),Hu (2022)

4.3. Data Encoding

Data coding includes the following three parts: open coding, spindle coding and selective coding. Through these three steps, a preliminary research theory can be formed. This dissertation uses nvivo20 as an auxiliary tool for coding management. Finally, The study ultimately obtained 41 personal and media interview research samples for intelligent unmanned stores. Considering the need of theoretical saturation test, 2/3 (27 in total) of the research samples were used for coding analysis, and the remaining 1/3 (14 in total) of the research samples were used for theoretical saturation test. Details are as follows：

Elaboration by the author

Figure 3.2 Nvivo20 encoding

4.3.1.   Open Coding

Before the open coding, the original sample data needs to be abstracted. The workload of this step is quite huge. All data materials need to be abstracted. After this step, the open coding can be started. Open coding is an in-depth interpretation and analysis of abstract concept coding to identify potential patterns and topics in data. Through repeated inspection and comparison of data, we can find different dimensions and levels of data and form subcategory classification. This process becomes open coding.

This dissertation mainly extracts abstract concepts from the sample data of intelligent shopping solutions of JD intelligent unmanned store, JDX intelligent unmanned supermarket, Alibaba "TaoCoffee" intelligent unmanned supermarket and Amazon Go intelligent unmanned convenience store, and then carries out Abstract coding. The main goal of this dissertation is to compare the intelligent shopping solutions of the world's mainstream retail enterprises, design a questionnaire to investigate, obtain the evaluation of the factors affecting customer experience on each node of the four intelligent shopping solutions, and then obtain the best solution according to the evaluation. Therefore, it is necessary to find out the differences between the four solutions, When abstracting concepts in the open coding and spindle coding stages, the functional concept abstraction is adopted, and it is not too abstract. Although too abstract can be concise, the meaning expression may not be clear, which is not conducive to the research results.

The specific open codes are described in the table below： Annex B

From the above analysis, we can see that JD intelligent unmanned convenience store has a total of 41 subcategory definitions, including 10 entering stores, 21 Intelligent shopping, 11 Intelligent settlement, and 2 leaving stores. The sub category of entering the store mainly includes: a1: clear and understandable shopping guide a2: convenience of customer payment a3: convenience of new user login a4: convenience of customer entering the store a5: complexity of new user registration a6: customer login technology; A7: face recognition technology a8: security assurance for unmanned supermarkets a9: customer payment security a10: abnormal information processing. The sub category of intelligent shopping includes: b1: flow funnel big

data analysis b2: refined operation data support b3: thermal map big data analysis and display b4: big data image search b5: computer vision customer action trajectory monitoring b6: computer vision identification product display image b7: low cost of intelligent shelf b8: intelligent shelf operation management b9:AIOT upload data b10: deep learning b11: distributed cloud computing b12: edge computing b3: intelligent sensor edge computing recognition Change of commodity status b14: intelligent sensor b15: intelligent identification of tally system b16: intelligent prompt of tally system b17: reduction of operation cost of tally system b18: digital operation b19: fluency of shopping process b20: error in commodity identification rate b21: high face recognition rate of jd.com. The sub category of intelligent settlement mainly includes: c1: intelligent settlement station payment c2: intelligent settlement station weighing c3: settlement station computer vision recognition commodity c4: intelligent settlement station aiot upload customer and commodity information c5: intelligent settlement station has the function of commodity identification and signing c6: intelligent settlement station has low cost c7: mobile payment technology c8: face recognition payment technology c9: the accuracy of all recognition is not high c10: some commodities are RFID assisted c11: recognition errors are easy to repair. The sub category of leaving the store mainly includes: d1: accuracy of settlement feedback d2: timeliness of settlement information feedback.

JDX intelligent unmanned supermarket has a total of 24 sub category definitions, including 6 entering stores, 9 intelligent shopping, 7 intelligent settlement and 2 leaving stores. The sub category of entering the store mainly includes: e1: easy to understand and clear shopping guide e2: convenience of new user payment e3: fluency of customer entering the store e4: face recognition authentication e5: complexity of new user registration e6: security assurance of unmanned supermarket. The sub category of intelligent shopping mainly includes: f1: computer vision customer action trajectory monitoring f2: computer vision customer stay time monitoring f3: computer vision recognition of customer physical behavior f4: computer vision recognition of customer purchase quantity f5: image recognition technology f6: big data analysis of customer shopping preferences f7: big data search picture f8:AIOT technology f9: distributed cloud computing. The sub category of intelligent settlement mainly includes: g1: face recognition identity g2: mobile payment technology g3:rfid tag technology g4:rfid identification technology g5:rfid

technology risk g6: error in commodity identification rate g7: JD face recognition rate is high. The sub category of leaving the store mainly includes: h1: accuracy of settlement feedback h2: timeliness of settlement information feedback.

There are 35 sub category definitions for Alibaba's "TaoCoffee" supermarket, including 6 stores, 21 intelligent shopping, 5 Intelligent settlement, and 3 stores. The sub category of entering the store mainly includes: i1: easy to understand and clear shopping guide i2: convenience for new users to enter the store i3: convenience for customers to pay i4: complexity of new user registration i5: security guarantee for unmanned supermarkets i6: exception information processing. The sub category of intelligent shopping mainly includes: j1: composition of touch-screen desktop virtual shelf j2: face recognition technology j3: face recognition payment j4: voice recognition order j5: distributed cloud computing j6: hybrid networking technology j7: biometric autonomous perception and learning technology j8: convenience of customers' intelligent shopping j9: convenience of picking up food j10: composition of automatic settlement waiting for call processing system j11: function of customer store dynamic line tracking and analysis system j12: computer vision combined with big data recognition Customer identity j13: computer vision recognition action route j14: computer vision capture shelf dwell time j15: computer vision capture shelf shopping j16: in-depth learning to optimize the display of goods in the store j17: in-depth learning to optimize goods j18: in-depth learning to improve the retail efficiency of merchants J19: CPU endurance j20: image recognition rate j21: the maximum number of people in the supermarket. The sub category of intelligent settlement mainly includes: k1: mobile payment technology k2:rfid tag k3:rfid automatic identification technology k4: customer payment convenience. The sub category of leaving the store mainly includes: l1: prompt timely after payment l2: accuracy of settlement feedback l3: timeliness of settlement information feedback.

Amazon Go unmanned convenience store has a total of 29 subcategory definitions, including 6 entering stores, 19 intelligent shopping, 2 Intelligent settlement and 2 leaving stores. The sub category of entering the store mainly includes: m1: easy to understand and clear shopping guide m2: diversity of customer entering the store m3: complexity of new user registration m4: supermarket security assurance m5: store customer identity filtering m6: exception information processing. The sub category of intelligent shopping mainly includes: n1: hardware equipment

used in supermarkets n2: computer vision recognition of customer identity n3: computer vision acquisition of customer action trajectory n4: computer vision recognition of customer shopping action n5: computer vision recognition of goods n6: image recognition technology n7: sensor recognition system composition n8: customer face recognition identity n9: customer skin color recognition identity n10: voice recognition of customer location n11: voice recognition of customer approximate action n12: voice recognition of customer behavior habits n13: voice recognition customer residence time n14: big data analysis to determine user preferences n15: big data analysis to determine the most popular products in supermarkets n16: pressure sensors and weighing sensors to determine the current status of products n17: sensor fusion to match customers and products n18: products are automatically added to the app virtual shopping basket n19: consumer shopping behavior misjudgment. The sub category of intelligent settlement mainly includes: o1: automatic settlement in the designated settlement area o2: click online payment or secret free payment when customers leave the store. The sub category of leaving the store mainly includes: p1: transaction amount and other information sent to Amazon appp2: timeliness of settlement information feedback.

4.3.2. Axial Coding

On the basis of open coding, spindle coding further reorganizes and refines abstract concepts, transforms them into theoretical categories and patterns, and discovers the correlation and dependence between concepts to form a preliminary theory. At this stage, instead of simple abstract concepts, functional abstract concepts are used to facilitate comparison and identify differences.

The specific axial codes are described in the table below：Annex C

To sum up, jd.com intelligent unmanned convenience store has a total of 16 main category definitions, including 5 entering stores, 7 intelligent shopping, 2 intelligent settlement and 2 leaving stores. The main categories of entering the store mainly include: jda1: convenience of customers entering and leaving the store jda2: complexity of new user registration jda3: customer login method jda4: security guarantee jda5: exception information processing. The main categories of intelligent shopping mainly include: jdb1: big data jdb2: computer vision jdb3: intelligent shelf

jdb4: artificial intelligence technology jdb5: intelligent sensor jdb6: tally system jdb7: shopping risk. The main category of intelligent settlement mainly includes: jdc1: intelligent settlement desk jdc2: intelligent payment technology jdc3: shopping risk and fault tolerance. The main category of leaving the store mainly includes: jdd1: accuracy and timeliness of settlement feedback.

JDX intelligent unmanned supermarket has a total of 10 main category definitions, including 3 entering stores, 3 intelligent shopping, 3 intelligent settlement and 1 leaving stores. The main categories of entering the store mainly include: jde1: convenience of customers entering and leaving the store, jde2: complexity of new user registration, and jde3: security assurance of unmanned supermarkets. The main category of intelligent shopping mainly includes: jdf1: computer vision jdf2: big data jdf3: intelligent technology. The main category of intelligent settlement mainly includes: jdg1: intelligent payment technology jdg2:rfid technology jdg3: intelligent shopping risk. The main category of leaving the store mainly includes: jdh1: accurate and timely settlement feedback.

There are 15 main category definitions in Alibaba's "TaoCoffee" unmanned supermarket, including 4 entering stores, 8 intelligent shopping, 2 Intelligent settlement and 1 leaving stores. The main categories of entering the store mainly include: ali1: convenience of customers entering and leaving the store, ali2: complexity of new user registration, ali3: security guarantee of unmanned supermarket, ali4: exception information processing. The main categories of intelligent shopping mainly include: alj1: touch screen desktop virtual shelf alj2: intelligent technology alj3: shopping convenience alj4: automatic settlement waiting for call processing system alj5: customer in store dynamic tracking and analysis system alj6: computer vision recognition alj7: deep learning alj8: shopping risk. The main category of intelligent settlement mainly includes: alk1: mobile payment technology ALK2: RFID technology. The main category of leaving the store mainly includes: all1: accuracy and timeliness of settlement feedback.

Amazon Go intelligent unmanned convenience store has a total of 15 main category definitions, including 4 entering stores, 9 intelligent shopping, 1 intelligent settlement and 1 leaving store. The main categories of entering the store mainly include: ymm1: convenience of customers entering and leaving the store ymm2: complexity of new user registration ymm3: safety of customers entering the store

ymm4: exception information processing. The main categories of intelligent shopping mainly include: ymn1: hardware equipment used in supermarkets ymn2: computer vision ymn3 sensor recognition system ymn4: identity recognition mode ymn5: speech recognition ymn6: big data ymn7: sensor fusion ymn8: intelligent shopping ymn9: shopping recognition risk. The main category of intelligent settlement mainly includes: ymo1: intelligent settlement. The main scope of leaving the store mainly includes: ymp1: timeliness of settlement information feedback.

4.3.3. Selective Coding

Selective coding is to test and verify the main category, conduct empirical research, verify the effectiveness and applicability of the theory, and further refine and revise the theory. The results obtained by selective coding are listed below:

1. Selective coding of intelligent shopping solution for JD intelligent unmanned convenience store

Elaboration by the author
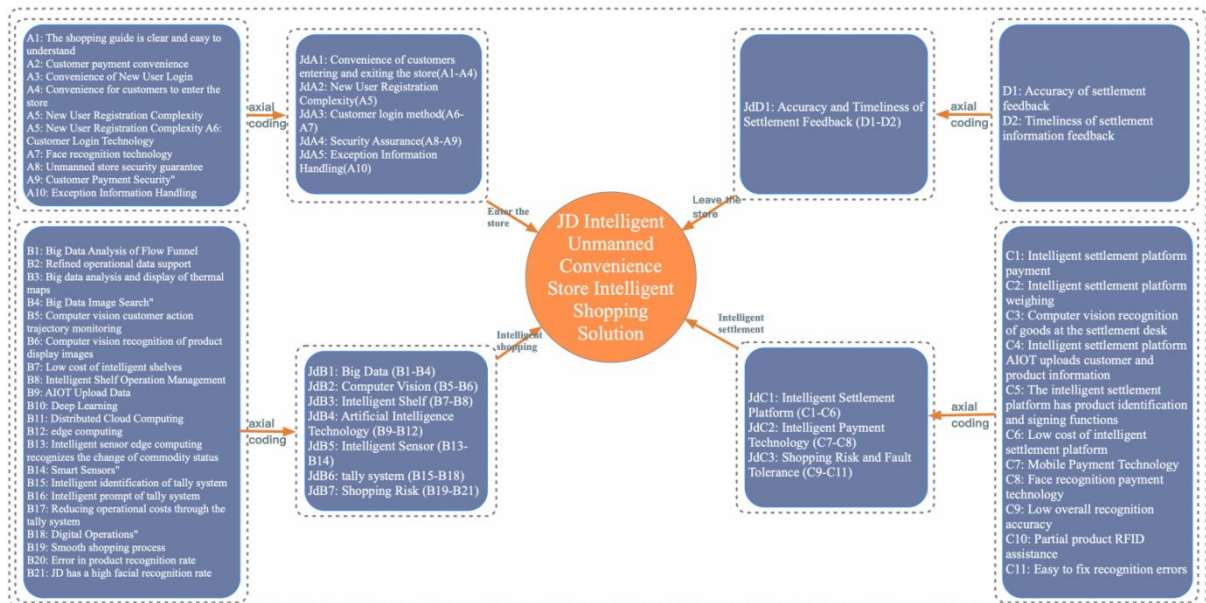
Figure 3.3 Selective coding of JD's intelligent unmanned convenience store intelligent shopping solution

2. Selective coding of intelligent shopping solution for JDX intelligent unmanned supermarket

Elaboration by the author
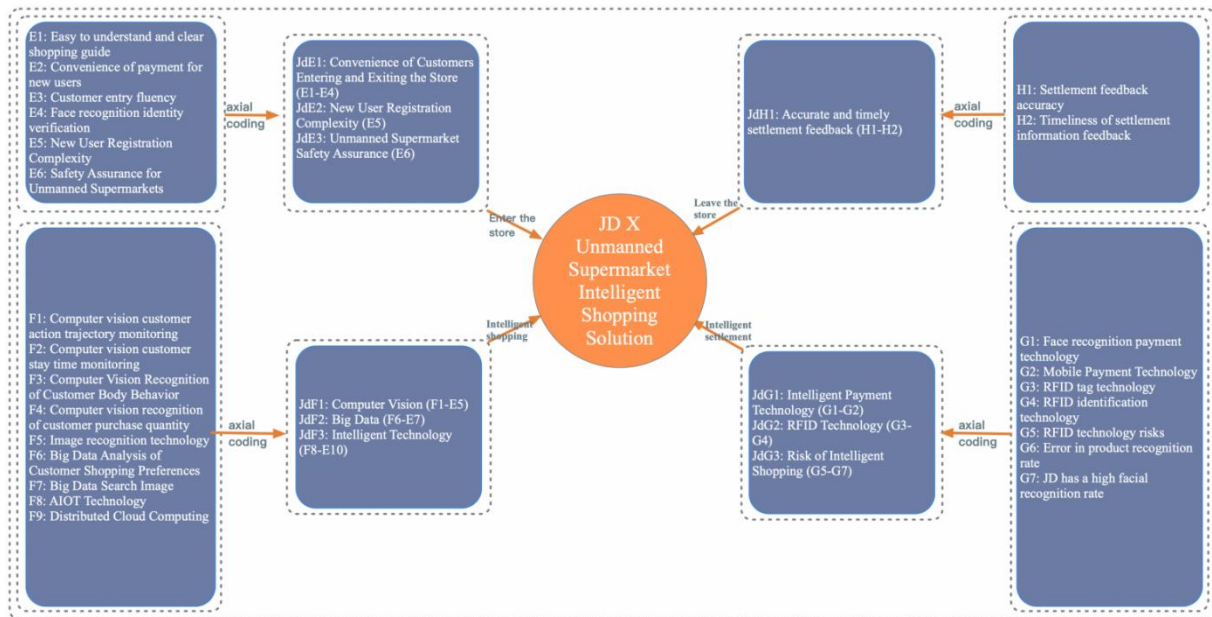
Figure 3.4 JDX Intelligent Unmanned Supermarket Intelligent Shopping Solution Selective Coding

3. Selective coding of intelligent shopping solution for Alibaba "TaoCoffee" intelligent unmanned supermarket

Elaboration by the author
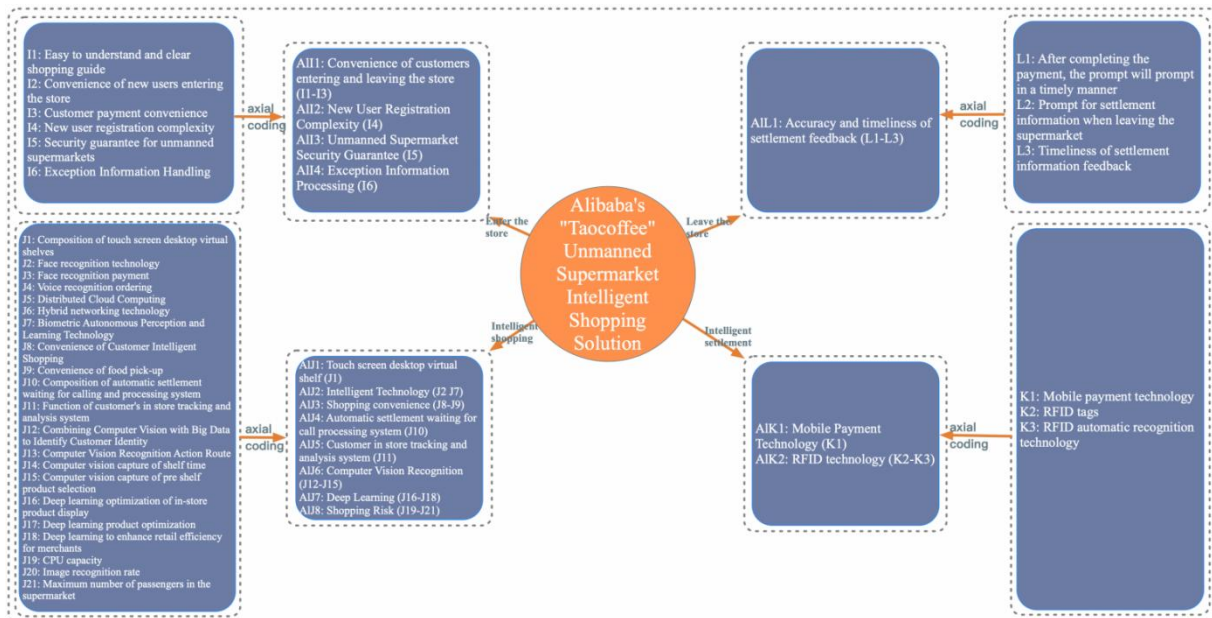
Figure 3.5 Selective coding of "TaoCoffee" intelligent unmanned supermarket intelligent shopping solution

4.Amazon Go intelligent unmanned convenience store intelligent shopping solution selective coding

Elaboration by the author

56

Figure 3.6 Amazon Go intelligent unmanned convenience store intelligent shopping solution

selective coding

4.4. Theoretical Saturation Verification

According to the theoretical saturation requirements of grounded theory, this dissertation uses 1/3 (14) data samples left in advance to test the theoretical saturation of the conceptual framework of customer experience of intelligent solutions for intelligent unmanned stores in retail enterprises. The test results show that 5-7 of the sample data of JD intelligent unmanned convenience store, 5-7 of the sample data of JDX unmanned supermarket After verification, 7-9 of the sample data of Alibaba's "TaoCoffee" intelligent unmanned supermarket and 13-15 of the sample data of Amazon Go intelligent unmanned convenience store also reflect the main categories that affect the customer experience of intelligent solutions for intelligent unmanned stores, including 16 main categories and 41 sub categories of JD's intelligent unmanned convenience store, 10 main categories and 24 sub categories of JD's intelligent x unmanned supermarket, and Alibaba's "TaoCoffee" The unmanned supermarket has 15 main categories and 35 sub categories, and Amazon Go intelligent unmanned convenience store has 15 main categories and 29 sub categories. There are no new categories and interrelations. Therefore, the conceptual framework of customer experience of intelligent solutions for intelligent unmanned stores obtained in this study has reached theoretical saturation.

4.5. Final Theoretical Research and Analysis

The final theoretical research is based on the verification of theoretical saturation, and the general business architecture of intelligent shopping solutions for intelligent unmanned stores is obtained through the overall framework of categories, subcategories and abstract concepts of retail enterprises such as JD intelligent unmanned convenience stores, JD intelligent x unmanned supermarkets, Alibaba "TaoCoffee" unmanned supermarkets, and Amazon Go intelligent unmanned convenience shopkeepers. If retail enterprises need to develop new functions, You can refer to the following business architecture diagram and technical category, as shown in the following figure：

Elaboration by the author
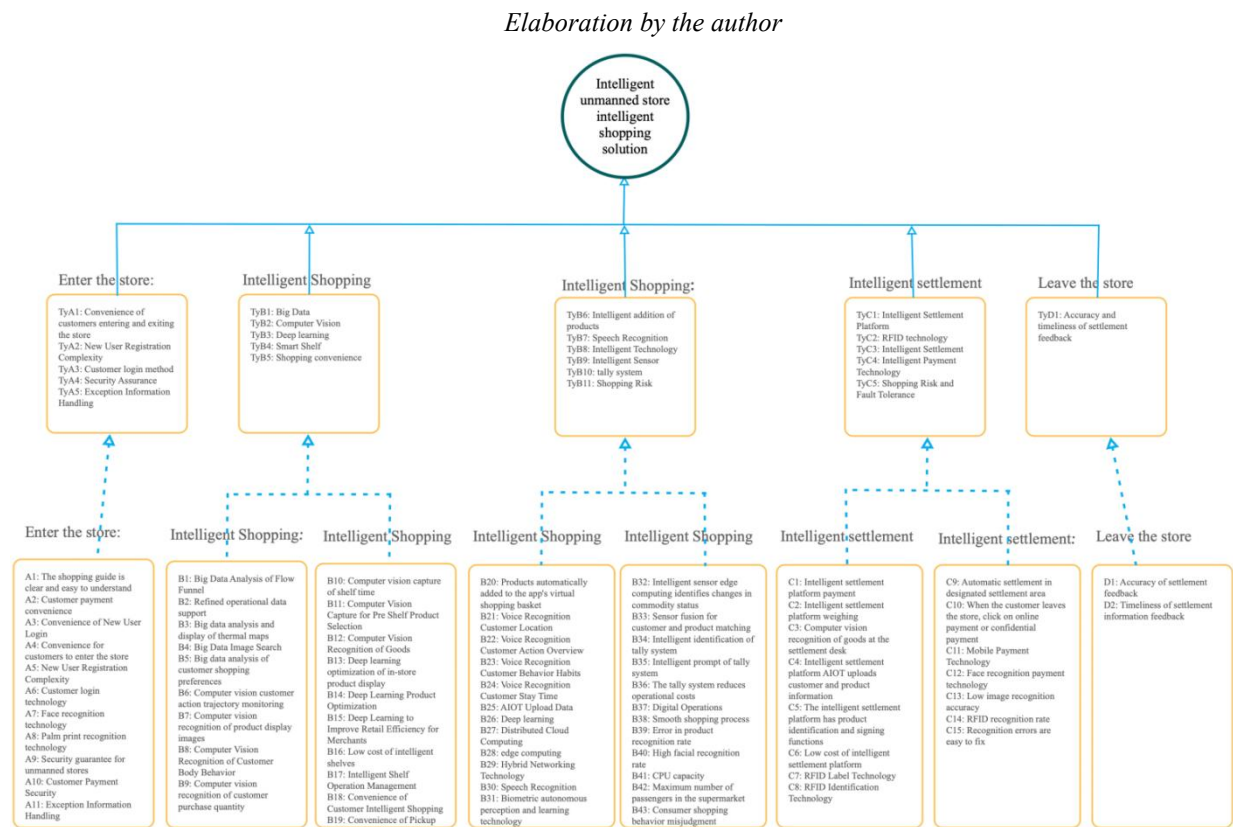
Figure 4.1 General business architecture diagram of intelligent unmanned store intelligent

shopping solution

Elaboration by the author

Table 4.1 Intelligent unmanned store intelligent shopping solution

Subcategory extraction	Conceptual abstraction
TyA1: Convenience of customers entering and exiting the store	A1: The shopping guide is clear and easy to understand A2: Customer payment convenience A3: Convenience of New User Login A4: Convenience for customers to enter the store
TyA2: New User Registration Complexity	A5: New User Registration Complexity
TyA3: Customer login method	A6: Customer login technology A7: Face recognition technology A8: Palm print recognition technology
TyA4: Security Assurance	A9: Security guarantee for unmanned stores A10: Customer Payment Security
TyA5: Exception Information Handling	A11: Exception Information Handling
TyB1: Big Data	B1: Big Data Analysis of Flow Funnel B2: Refined operational data support B3: Big data analysis and display of thermal maps B4: Big Data Image Search B5: Big data analysis of customer shopping preferences
TyB2: Computer Vision	B6: Computer vision customer action trajectory monitoring B7: Computer vision recognition of product display images B8: Computer Vision Recognition of Customer Body Behavior B9: Computer vision recognition of customer purchase quantity B10: Computer vision capture of shelf time B11: Computer Vision Capture for Pre Shelf Product Selection B12: Computer Vision Recognition of Goods
TyB3: Deep learning	B13: Deep learning optimization of in-store product display B14: Deep Learning Product Optimization B15: Deep Learning to Improve Retail Efficiency for Merchants
TyB4: Intelligent Shelf	B16: Low cost of intelligent shelves B17: Intelligent Shelf Operation Management
TyB5: Shopping convenience	B18: Convenience of Customer Intelligent Shopping B19: Convenience of Pickup
TyB6: Intelligent addition of products	B20: Products automatically added to the app's virtual shopping basket
TyB7: Speech Recognition	B21: Voice Recognition Customer Location B22: Voice Recognition Customer Action Overview B23: Voice Recognition Customer Behavior Habits B24: Voice Recognition Customer Stay Time
TyB8: Intelligent Technology	B25: AIOT Upload Data B26: Deep learning B27: Distributed Cloud Computing B28: edge computing B29: Hybrid Networking Technology B30: Speech Recognition B31: Biometric autonomous perception and learning technology
TyB9: Intelligent Sensor	B32: Intelligent sensor edge computing identifies changes in commodity status

	B33: Sensor fusion for customer and product matching
TyB10: tally system	B34: Intelligent identification of tally system B35: Intelligent prompt of tally system B36: The tally system reduces operational costs B37: Digital Operations
TyB11: Shopping Risk	B38: Smooth shopping process B39: Error in product recognition rate B40: High facial recognition rate B41: CPU capacity B42: Maximum number of passengers in the supermarket B43: Consumer shopping behavior misjudgment
TyC1: Intelligent Settlement Platform	C1: Intelligent settlement platform payment C2: Intelligent settlement platform weighing C3: Computer vision recognition of goods at the settlement desk C4: Intelligent settlement platform AIOT uploads customer and product information C5: The intelligent settlement platform has product identification and signing functions C6: Low cost of intelligent settlement platform
TyC2: RFID technology	C7: RFID Label Technology C8: RFID Identification Technology
TyC3: Intelligent Settlement	C9: Automatic settlement in designated settlement area C10: When the customer leaves the store, click on online payment or confidential payment
TyC4: Intelligent Payment Technology	C11: Mobile Payment Technology C12: Face recognition payment technology
TyC5: Shopping Risk and Fault Tolerance	C13: Low image recognition accuracy C14: RFID recognition rate C15: Recognition errors are easy to fix
TyD1: Accuracy and timeliness of settlement feedback	D1: Accuracy of settlement feedback D2: Timeliness of settlement information feedback

4.6. Summary of This Section

To sum up, we get the open coding, spindle coding, and selective coding of the intelligent shopping solution for retail enterprises' intelligent unmanned stores. Through the analysis of the main category, sub category, and category description, we find the differences in the functions and technologies of different nodes of the intelligent shopping solution for retail enterprises' intelligent unmanned stores, so as to prepare for the following scale research.

Chapter 5 – Research based on scales

Through the research based on grounded theory, the factors that affect the intelligent shopping solutions of retail enterprises' intelligent unmanned stores are obtained. In order to achieve the main goal of this dissertation to find a mature solution for intelligent shopping of retail enterprises' intelligent unmanned stores, the factors that affect the intelligent shopping solutions of retail enterprises' intelligent unmanned stores need to be copy written and designed into a language that customers can easily understand, And investigate the customer experience by asking for coupons, so as to get the influencing factors with high scores of each option, and then re combine them, and finally draw a conclusion.

5.1. Scale Research Process Analysis

Based on the need to score the factors that affect the intelligent shopping solutions of retail enterprises' intelligent unmanned stores, we chose the Likert scale as the research tool. Likert scale was formed by the American social psychologist Likert in 1932 on the basis of the original total plus scale(Likert, 1932). It belongs to the score plus scale. Items with the same concept are scored in the way of aggregation, and individual or individual items are meaningless, The table is generally set with five kinds of answers. There are five kinds of answers: very dissatisfied, dissatisfied, general, satisfied and very satisfied. They are recorded as 1, 2, 3, 4 and 5. The higher the value, the more satisfied the sample is with the item and the higher the score. According to the characteristics of the Likert scale and the scoring characteristics of the Likert scale used in this dissertation, the Likert scale will have the following development process, as shown in the following figure：

Elaboration by the author
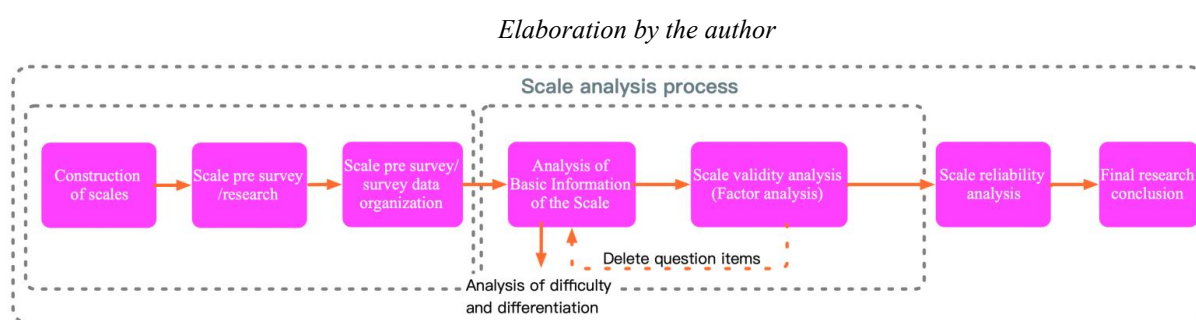
Figure 5.1 Scale research flow chart

From the above figure, we can see that the research on the evaluation system of intelligent shopping solutions for retail enterprises' intelligent self-service stores in this

dissertation has gone through the following steps: 1. Build a coupon questionnaire, and build scoring options through the questionnaire. 2. Pre survey/survey the questionnaire. First, use the questionnaire to pre evaluate and analyze the data. If the questionnaire is expressed or other questions, redesign the coupon questionnaire. After redesigning the scale, the questionnaire will be issued. 3. Pre survey of the scale/collation of survey data. After pre survey/survey of the scale, the questionnaire survey data needs to be recovered, and then the survey data will be sorted out. 4. Analysis of the basic information of the scale, including: frequency, descriptive analysis. 5. Analysis of the validity of the scale, mainly through exploratory factor analysis and confirmatory factor analysis. 6. Analysis of the reliability of the scale.

5.2. Questionnaire Design

5.2.1. Scale Making

According to the coding results of the customer evaluation of the intelligent shopping solution of retail enterprises' retail enterprises' intelligent unmanned stores based on the grounded theory in the above chapters, we can design the main content of the questionnaire for the customer evaluation of the intelligent shopping solution of retail enterprises' retail enterprises' intelligent unmanned stores, and then add the screening conditions and basic information, which are three parts in total. The first part is the screening conditions of the subjects, which adopts the form of multiple-choice questions, The last item is used as the screening and skip condition; The second part is the research on the customer experience of intelligent shopping in the intelligent unmanned store. Because the problems are relatively concentrated and clear, the form of matrix scale is adopted; The third part, the basic information of the subjects, adopts the combination of multiple-choice and single choice. See Annex A for the contents of part I and part II and part III.

The contents of the items applied in the following chapters are replaced by numbers.

5.2.2. Data Collection of The Scale

The questionnaire survey method of this study is mainly through "online" and "offline" joint survey. The questionnaire is distributed online through "coupon star" and "wechat coupon". The questionnaire is distributed offline through dissertation documents. In order to ensure the universality of the survey results, the same equipment and computer can only answer once and IP restrictions are used online. At the same time, the questionnaire survey method is organically integrated with the convenient sampling principle. The objects of the questionnaire and coupon issuing people in this survey are mainly the members of the R&D team of intelligent unmanned stores and R&D unmanned stores, as well as high-quality people. These high-quality people do not necessarily mean that they have experienced the above mentioned JD intelligent unmanned stores, JDX unmanned stores, "TaoCoffee" intelligent unmanned stores, and Amazon Go intelligent unmanned convenience stores, but people with a certain degree can pass the screening.

Wang(2021) thinks that according to existing research, when the sample size of the data is 5-10 times the number of items, although there is some error, generally good measurement results can be obtained, and in principle, the larger the sample size of the data, the better the effect.In order to ensure that the sample size of the data is 5-10 times of the number of items, the customer evaluation scale of the intelligent shopping solution of the intelligent unmanned store of retail enterprises measures 40 items, and the number of survey coupons issued is at least 200-400, so a total of 326 questionnaires were issued online and offline. In this study, 11 questionnaires with main screening conditions, too short answer time, serious logical contradictions in the answers, and all "1", "7" or other numbers were determined as partially invalid questionnaires and eliminated. 315 questionnaires were recovered with a recovery rate of 96% (the effectiveness of recovery needs to be>90%), which is about 7.8 times that of the measurement questions, meeting the number of samples required for factor analysis. For offline, we mainly distributed random anonymous questionnaires near the following intelligent unmanned stores, with a total of 20 questionnaires; A total of 306 questionnaires were distributed online, mainly through the ticket platform, and through wechat group forwarding or other forms.

5.2.3. Frequency Analysis of Basic Information of The Scale

The frequency analysis of the basic information of the scale is mainly to screen and use the issued vouchers, as described in the following table,After screening, a total of 315 coupons were obtained, with males accounting for 38.1%, females accounting for 61.9%, High school, technical secondary school and below (including ongoi studies) accounting for 4.7%, Junior college and underrate (including ongoi studies) accounting for 37.7%, and Master's degree or above (including ongoi studies) accounting for 62.9%.

Elaboration by the author

Table 5.1 Frequency analysis results

Variable	Option	Frequency	Percent	Valid Percent	Cumulativ Percent
Gender	male	121	38.1	38.1	38.1%
	female	197	61.9	61.9	100%
Education	High school, technical secondary school and below (including ongoing studies)	15	4.7	4.7	4.7%
	Junior college and undergraduate (including ongoing studies)	105	33	33	37.7%
	Master's degree or above (including ongoing studies)	198	62.9	62.9	100%

5.3. Scale Test and Data Analysis

The test of the scale is mainly carried out through factor analysis, which is a branch of multivariate statistical analysis technology. By studying the internal dependence of many variables, the basic structure of observation data is explored, and a few hypothetical variables are used to represent the basic data structure. These hypothetical variables can reflect the main information represented by many original observation variables, And explain the interdependence between these observed variables. Factor analysis is divided into two forms: exploratory factor analysis and confirmatory factor analysis. In this study, 280 samples obtained from the actual survey were used as exploratory factor analysis and confirmatory factor analysis.

5.3.1. Reliability Analysis

Reliability analysis is used to study the reliability and accuracy of quantitative data (especially attitude scale questions). In this study, the main factors are measured in the form of scales, so the inspection of the data quality of the measurement results is an important premise to ensure the significance of the follow-up analysis. First through Cronbach α The coefficient reliability test method analyzes the internal consistency of each latitude, if α If the coefficient is higher than 0.8-0.9, the reliability is high; If the value is between 0.7 and 0.8, the reliability is good; If the value is between 0.6 and 0.7, the reliability is acceptable; If this value is less than 0.6, the reliability is poor.

In this analysis, the reliability analysis results are shown in the table below. JD intelligent shopping solution, JDX intelligent shopping solution, alibaba's "TaoCoffee" intelligent shopping solution, Amazon Go intelligent shopping solution and the number of two-level latitude reliability coefficient intelligent shopping solution are all in the range of 0.8-1, which shows that the scales used in this study have good internal consistency and high reliability.

Elaboration by the author

Table 5.1 Intelligent Shopping Solution Reliability Statistics

Variable	Cronbach's Alpha	N of Items
JD Intelligent Shopping Solution	0.899	8
JDX Intelligent Shopping Solution	0.910	9
Alibaba's "TaoCoffee" Intelligent Shopping Solution	0.920	10
Amazon Go Intelligent Shopping Solution	0.922	10
Intelligent Shopping Solution	0.973	37

5.3.2. Scale Discrimination Analysis

Scale discrimination analysis is a type of project analysis, which also includes difficulty analysis. Due to the fact that most people can answer correctly after pre testing the scale, the difficulty level is low, so it will not be further elaborated here. Differentiation analysis is the degree to which test items distinguish the attributes

and characteristics of the measured object. The project discrimination analysis in this article will sum up the scores of each participant in each item of the questionnaire, and sort them in high or low order. The top 27% of the total score will be selected as the high group, and the bottom 27% will be selected as the low group. The significance test will be conducted on the difference in the average score of each item between the high and low groups of participants. The last test will determine whether there is a significant difference in the high and low groups of each question. If a significant difference is reached, This indicates that the question has a certain level of discernment and should be retained; Otherwise, it will be deleted. The discriminability analysis is judged by standard deviation. If the standard deviation of a project item is greater than 0.5, it indicates that the item has reached a significant level, and the discriminability of the problem items in this scale is high. Differentiation analysis can also be conducted using the CR value method, which excludes items that did not reach a significant level in the T-test and items that were not significantly correlated with the total score of the questionnaire or had a correlation coefficient less than 0.3. The specific content is shown in the following figure：

Elaboration by the author

Table 5.2 Scale discrimination analysis table

Num	Sample size	T	P
JD-01	85	9.933	0.000**
JD-02	85	10.342	0.000**
JD-03	85	12.148	0.000**
JD-04	85	10.683	0.000**
JD-05	85	13.388	0.000**
JD-06	85	11.894	0.000**
JD-07	85	12.083	0.000**
JD-08	85	14.038	0.000**
JDX-09	85	13.092	0.000**
JDX-10	85	11.243	0.000**
JDX-11	85	13.928	0.000**
JDX-12	85	13.612	0.000**
JDX-13	85	13.114	0.000**
JDX-14	85	12.407	0.000**
JDX-15	85	7.340	0.000**
JDX-16	85	12.982	0.000**
JDX-17	85	12.439	0.000**
TKF-18	85	16.787	0.000**
TKF-19	85	13.598	0.000**
TKF-20	85	11.899	0.000**
TKF-21	85	11.588	0.000**
TKF-22	85	13.299	0.000**
TKF-23	85	13.509	0.000**
TKF-24	85	12.039	0.000**
TKF-25	85	12.304	0.000**
TKF-26	85	13.696	0.000**
TKF-27	85	13.890	0.000**
AZG-28	85	15.359	0.000**
AZG-29	85	10.905	0.000**
AZG-30	85	13.092	0.000**
AZG-31	85	12.374	0.000**
AZG-32	85	12.356	0.000**
AZG-33	85	11.819	0.000**
AZG-34	85	13.057	0.000**
AZG-35	85	12.526	0.000**
AZG-36	85	13.884	0.000**
AZG-37	85	12.281	0.000**

The single sample t-test studies whether the quantitative data is obviously not equal to a certain number. For example, the sample attitude is obviously not neutral (neutral is the number 3). The T values in the above table are greater than 3, and the standard deviation is greater than 0.5, so there is no item to delete.

5.3.3. Exploratory Factor Analysis

Exploratory factor analysis (EFA) is mainly to find out the intrinsic nature of the transaction structure. Exploratory factor analysis is carried out through the following steps: 1. Kmo and Bartlett's test   2. Variance interpretation rate table 3. Factor load factor table after rotation. The specific analysis is as follows :

1.KMO and Bartlett's test

Elaboration by the author

Table 5.3 KMO and Bartlett's Test

KMO Value		0.970
Bartlett sphericity test	Approximate chi square	8200.146
	df	666
	P-value	.000

Factor analysis explores that quantitative data can be condensed into several aspects (factors), and each aspect (factor) corresponds to the item; If the kmo value is higher than 0.8, it indicates that it is very suitable for factor analysis; If this value is between 0.7 and 0.8, it indicates that it is suitable for factor analysis; If the value is between 0.6 and 0.7, factor analysis can be performed; If this value is less than 0.6, it indicates that factor analysis is not suitable; If the corresponding p value of Bartlett test is less than 0.05, it also indicates that factor analysis is suitable; It can be seen from the above table that kmo is 0.903, greater than 0.6, which meets the prerequisite requirements of factor analysis, meaning that the data can be used for factor analysis research. And the data passed Bartlett sphericity test (p<0.05), indicating that the research data is suitable for factor analysis.

2.Variance interpretation rate table

Elaboration by the author

<div align="center">Table 5.4 Total Variance Explained Table</div>

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	18.959	51.241	51.241	18.959	51.241	51.241	8.032	21.707	21.707
2	1.477	3.992	55.234	1.477	3.992	55.234	5.991	16.192	37.899
3	1.057	2.858	58.091	1.057	2.858	58.091	5.292	14.302	52.200
4	1.003	2.710	60.802	1.003	2.710	60.802	3.183	8.601	60.802
5	0.848	2.291	63.093	-	-	-	-	-	-
6	0.827	2.235	65.328	-	-	-	-	-	-
7	0.803	2.170	67.498	-	-	-	-	-	-
8	0.774	2.091	69.588	-	-	-	-	-	-
9	0.680	1.837	71.425	-	-	-	-	-	-
10	0.666	1.799	73.224	-	-	-	-	-	-
11	0.638	1.723	74.947	-	-	-	-	-	-
12	0.623	1.685	76.632	-	-	-	-	-	-
13	0.568	1.536	78.168	-	-	-	-	-	-
14	0.553	1.495	79.664	-	-	-	-	-	-
15	0.530	1.433	81.097	-	-	-	-	-	-
16	0.475	1.285	82.381	-	-	-	-	-	-
17	0.467	1.261	83.643	-	-	-	-	-	-
18	0.448	1.211	84.854	-	-	-	-	-	-
19	0.446	1.207	86.061	-	-	-	-	-	-
20	0.426	1.151	87.211	-	-	-	-	-	-
21	0.401	1.085	88.296	-	-	-	-	-	-
22	0.381	1.030	89.326	-	-	-	-	-	-
23	0.362	0.977	90.304	-	-	-	-	-	-
24	0.352	0.951	91.254	-	-	-	-	-	-
25	0.335	0.904	92.159	-	-	-	-	-	-
26	0.313	0.846	93.005	-	-	-	-	-	-
27	0.308	0.831	93.836	-	-	-	-	-	-
28	0.301	0.814	94.650	-	-	-	-	-	-
29	0.285	0.770	95.419	-	-	-	-	-	-
30	0.265	0.717	96.136	-	-	-	-	-	-
31	0.245	0.661	96.797	-	-	-	-	-	-
32	0.233	0.629	97.426	-	-	-	-	-	-
33	0.216	0.583	98.009	-	-	-	-	-	-
34	0.203	0.548	98.557	-	-	-	-	-	-
35	0.196	0.530	99.087	-	-	-	-	-	-
36	0.175	0.472	99.560	-	-	-	-	-	-
37	0.163	0.440	100.000						

It can be seen from the above table that four factors are extracted from factor analysis, and the eigenvalue values are greater than 1. The variance interpretation rates of these four factors after rotation are 21.707%, 16.192%, 15.315%, 14.302%, 8.601% respectively. The variance with the cumulative variance interpretation rate after rotation is 60.802%. It is generally considered that the variance with the cumulative variance interpretation rate greater than 60% after rotation is acceptable.

3.Factor load factor table after rotation

This research data is rotated by the maximum variance rotation method to find out the corresponding relationship between factors and research items. The following table shows the information extraction of factors for research items and the corresponding relationship between factors and research items. It can be seen from the table below that the similarity values of all research items are higher than 0.4, which means that there is a strong correlation between research items and factors, and factors can effectively extract information. After ensuring that the factor can extract most of the information of the research item, then analyze the corresponding relationship between the factor and the research item (when the absolute value of the factor load coefficient is greater than 0.4, it means that the item and the factor have a corresponding relationship).

Table 5.5 Rotated Component Matrixa

	Component			
	1	2	3	4
JD-01			**0.746**	
JD-02			0.418	**0.578**
JD-03		**0.546**	0.371	0.376
JD-04		0.451	**0.524**	
JD-05	0.323	0.431	**0.570**	
JD-06		0.386	**0.589**	
JD-07		**0.675**		
JD-08	0.342	**0.589**	0.435	
JDX-09	0.324	0.341	**0.617**	
JDX-10		**0.433**		0.684
JDX-11	0.312	**0.633**		
JDX-12	0.334	**0.599**	0.405	
JDX-13	0.398	**0.479**	0.431	
JDX-14	0.316	**0.478**	0.373	
JDX-15	0.302	**0.564**		
JDX-16		**0.542**	0.327	0.340
JDX-17	0.359	**0.572**	0.368	
TKF-18	0.529		**0.558**	0.313
TKF-19	0.447			**0.524**
TKF-20	**0.521**	0.438		
TKF-21	**0.514**	0.377		
TKF-22	0.500		**0.507**	
TKF-23	**0.552**	0.322		
TKF-24	**0.589**		0.403	
TKF-25	**0.549**		0.508	
TKF-26	0.490	**0.497**		
TKF-27	**0.578**	0.368	0.354	
AZG-28	**0.649**		0.468	
AZG-29	0.431			**0.672**
AZG-30	**0.624**			
AZG-31	**0.666**	0.308		
AZG-32	**0.659**			
AZG-33	**0.595**			0.422
AZG-34	**0.669**			
AZG-35	**0.596**			
AZG-36	**0.675**	0.433		
AZG-37	**0.586**	0.303		

Note: if the figures in the table are black, the black indicates that the absolute value of the load factor is greater than 0.4, and the red indicates that the common degree (common factor variance) is less than 0.4.

To sum up, after kmo and cronbach's alpha coefficient analysis, variance interpretation rate analysis and factor load coefficient analysis after rotation, each analysis can meet the requirements of each index, and each item can reflect the intrinsic essential structure of the transaction.

5.3.4. Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is mainly used to test whether a known specific structural model works as expected, by analyzing 315 data samples for data analysis.

1. Model fitting analysis

In this study, amos26 was used to conduct confirmatory factor analysis on the 4 potential variables and 37 observed variables of the questionnaire of intelligent shopping solutions for retail enterprises. The following table reflects the results of the confirmatory analysis of this study. Among the fitting indexes of the model, cmin/df (chi square degree of freedom ratio)=2.013, which is in the range of 1-3, indicating that the intelligent shopping solution questionnaire model is excellent; RMSEA (root mean square error)=0.057, which is within the range of<0.08, indicating that the model fitting is reasonable; SRMR (root mean square of standardized residuals)=0.0365, which is in the range of<0.05, indicating that the model is qualified; The values of CFI, TLI and RFI were all in the range of>0.90, and the model was acceptable; The values of pnfi and pcfi are all in the range of>0.50, indicating that they fit well, thus verifying the multidimensional hypothesis of intelligent shopping solutions.

Elaboration by the author

Table 5.6 Model Fitness Test

Index	Reference standards	Actual measurement results
CMIN/DF	1-3 is excellent, 3-5 is good	2.013
RMSEA	<0.05 is excellent, <0.08 is good	0.057
SRMR	<0.05	0.0365
IFI	>0.9 is excellent, >0.8 is good	0.920
TLI	>0.9 is excellent, >0.8 is good	0.915
CFI	>0.9 is excellent, >0.8 is good	0.920
PNFI	>0.5	0.798
PCFI	>0.5	0.861

2. Convergence validity (AVE) and combined reliability (CR) analysis

On the premise that the ISS model of the intelligent shopping solutions scale has good fitness, the convergence validity (AVE) and combined reliability (CR) of each latitude of the scale will be further tested. The inspection process calculates the standardization factor load of each measurement item at the corresponding latitude through the ISS model. Then, the convergence validity and combination reliability of each latitude are calculated through the calculation formula of ave and Cr. according to the standard, the minimum requirement of ave value is 0.5, and the minimum requirement of Cr value is 0.7, which indicates that it has good convergence validity and combination reliability. The calculation formula is as follows:

$AVE = \Sigma (\lambda)^2 / [\Sigma (\lambda)^2 + \Sigma (\theta)]$

$CR = (\Sigma\lambda)^2 / [(\Sigma\lambda)^2 + (\Sigma(\theta))]$ (Jöreskog and Sörbom, 1996)

λ: Is the indicator loading, which represents the degree to which the indicator variable can measure the characteristics of the potential variable（λ Greater than 0.71 is ideal). λ Square: represents the indicator reliability of individual observation variables. Bagozzi and Yi (1988) thought that λ It is better if the square is greater than 0.5. θ: The indicator error variance of the observed variable is the measurement error value. θ= (1-index reliability)=1- (standardized parameter of index variable).

According to the analysis results in the table below, in the validity test of the retail enterprise intelligent shopping solution scale, the ave value of each dimension has reached more than 0.5, and the CR value has reached more than 0.7. Based on the above analysis, it can be seen that each dimension has good convergence efficiency and combination reliability.

Elaboration by the author

Table 5.7 Convergence validity and combined reliability testing of intelligent shopping solutions in various dimensions

	Path Relationship		Std	AVE	CR
JD01	<---	JD-ISS	0.733		
JD02	<---	JD-ISS	0.631		
JD03	<---	JD-ISS	0.721		
JD04	<---	JD-ISS	0.743	0.5304	0.9001
JD05	<---	JD-ISS	0.777		
JD06	<---	JD-ISS	0.725		
JD07	<---	JD-ISS	0.718		
JD08	<---	JD-ISS	0.769		
JDX09	<---	JDX-ISS	0.779		
JDX10	<---	JDX-ISS	0.654		
JDX11	<---	JDX-ISS	0.75		
JDX12	<---	JDX-ISS	0.8		
JDX13	<---	JDX-ISS	0.766	0.5331	0.9104
JDX14	<---	JDX-ISS	0.723		
JDX15	<---	JDX-ISS	0.545		
JDX16	<---	JDX-ISS	0.739		
JDX17	<---	JDX-ISS	0.78		
TKF18	<---	TKF-ISS	0.796		
TKF19	<---	TKF-ISS	0.671		
TKF20	<---	TKF-ISS	0.719		
TKF21	<---	TKF-ISS	0.722		
TKF22	<---	TKF-ISS	0.77	0.5368	0.9204
TKF23	<---	TKF-ISS	0.696		
TKF24	<---	TKF-ISS	0.734		
TKF25	<---	TKF-ISS	0.725		
TKF26	<---	TKF-ISS	0.728		
TKF27	<---	TKF-ISS	0.758		
AZG28	<---	AZG-ISS	0.795		
AZG29	<---	AZG-ISS	0.638		
AZG30	<---	AZG-ISS	0.754		
AZG31	<---	AZG-ISS	0.768		
AZG32	<---	AZG-ISS	0.767	0.5449	0.9227
AZG33	<---	AZG-ISS	0.692		
AZG34	<---	AZG-ISS	0.753		
AZG35	<---	AZG-ISS	0.73		
AZG36	<---	AZG-ISS	0.733		
AZG37	<---	AZG-ISS	0.74		
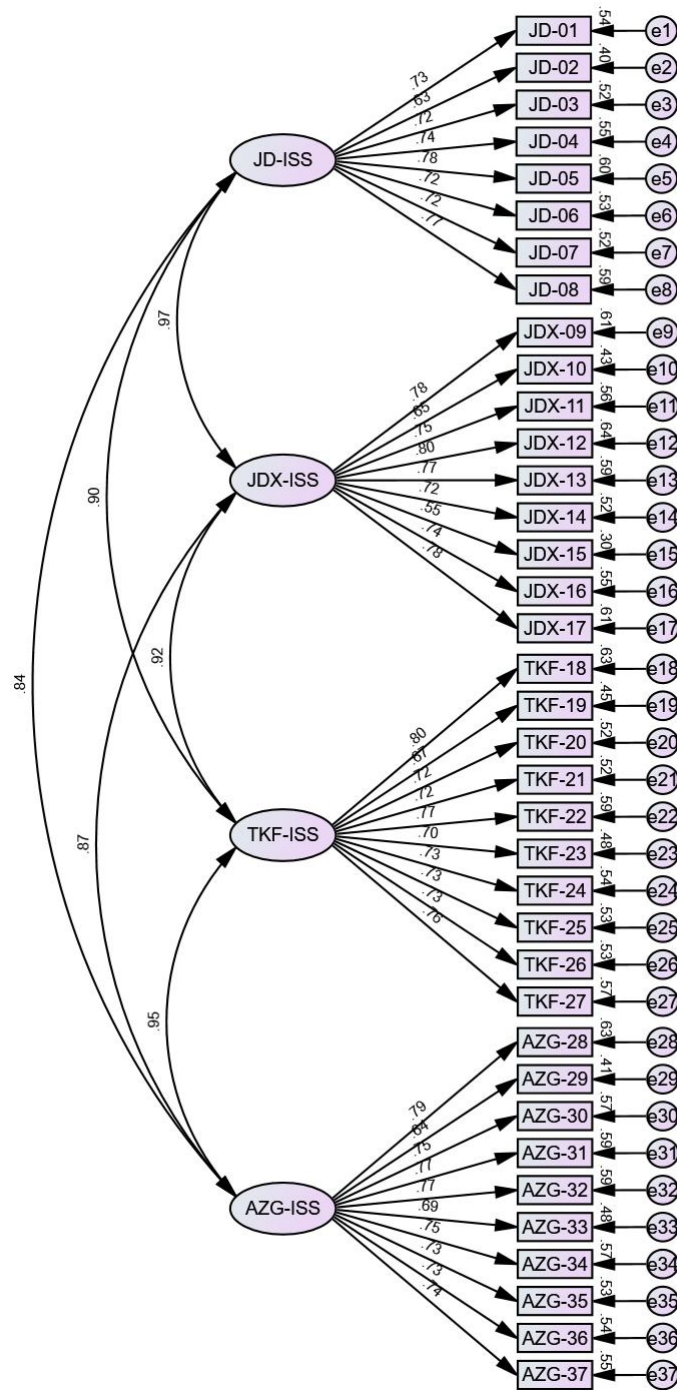
Figure 5.2 Scale model structure diagram

3. Construct validity analysis

Structural validity is used to measure items that should not be under the same factor, but are not under the same factor. The analysis results in the following table can be seen that in this test of discriminant validity, the standardized correlation coefficients between each potential variable are between 0.8-1.0, and the correlation

coefficients are greater than the square root of the ave value corresponding to each dimension. Therefore, it is suggested that there may be a higher-level factor structure in this model to build a second-order four factor ISS model of intelligent shopping solutions for retail enterprises' intelligent unmanned stores.

Elaboration by the author

Table 5.8 Test results of the differentiated validity of various dimensions of intelligent shopping solutions

	JD-ISS	JDX-ISS	TKF-ISS	AZG-ISS	AVE
JD-ISS	0.728				0.5304
JDX-ISS	0.971	0.730			0.5331
TKF-ISS	0.904	0.915	0.733		0.5368
AZG-ISS	0.841	0.874	0.945	0.738	0.5449

4.   Model construction and assumptions

According to the results of discrimination analysis, this study proposes the hypothesis that there may be higher-order factors. The specific description is as follows: (1) the intelligent shopping solution of retail enterprise intelligent unmanned store can be composed of four first-order factors and a high-order common factor. (2) There is no cross factor phenomenon for each topic, that is, each topic falls on the single factor constructed. (3) Each error term is independent. Use amos26 to draw the path map of the second-order four factor ISS model, as shown in the following figure：
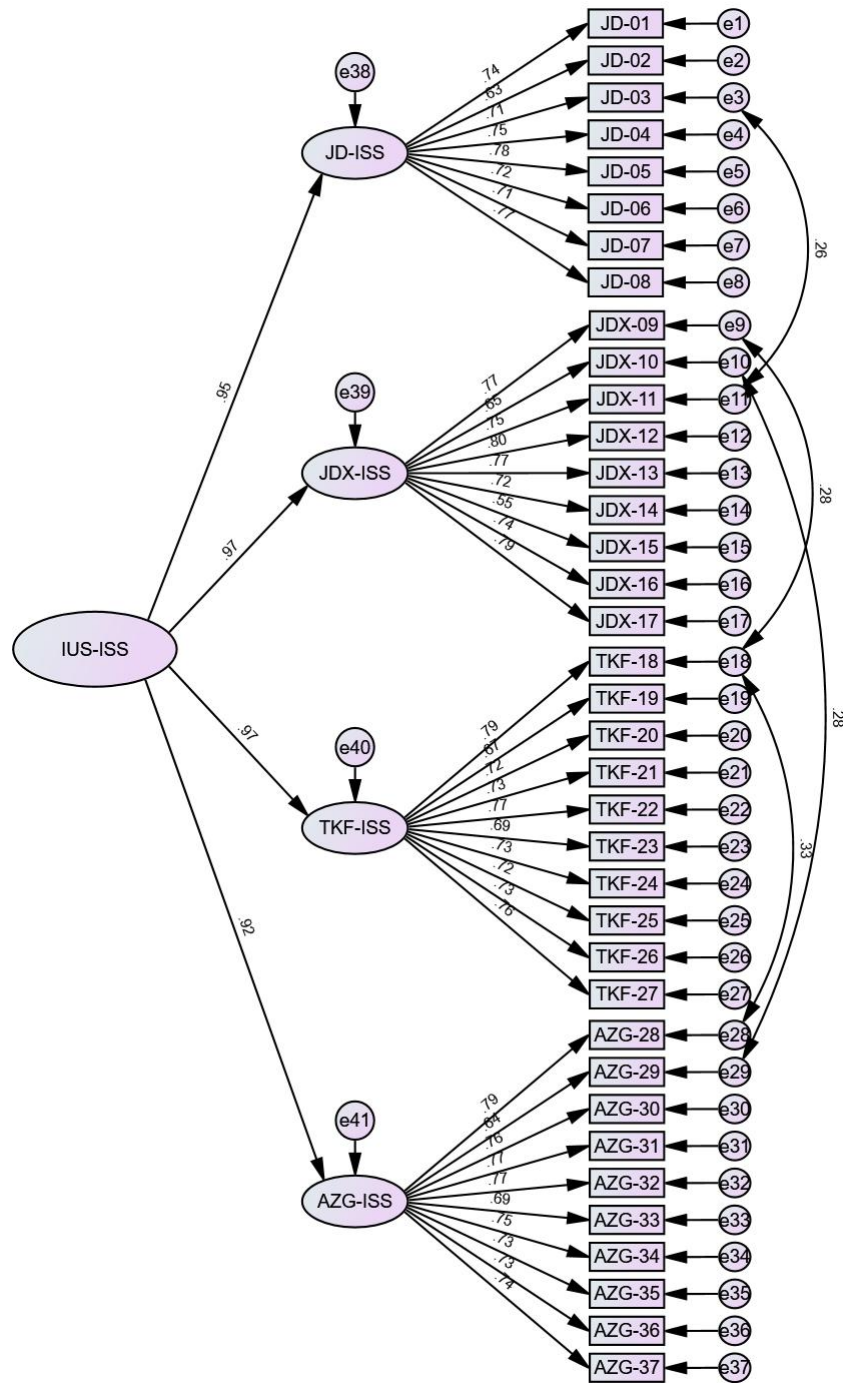
Figure 5.3 Scale model construction diagram

As shown in the above figure, since CMIN/DF, RMSEA, IFI, TLI and CFI have not reached the most ideal indicators, it is necessary to use the MI indicator correction method to correct the covariance relationship of the model. Mi represents the minimum chi square value reduced by the model re estimation after a previously

fixed parameter is released. When the MI value is greater than 3.84, it is considered to be large enough. By viewing the correction indicators in the Amos operation results, because the MI values of e3-e11, e9-e18, e10-e29 and e18-e28 are 19.173, 34.515, 22.399 and 41.109 respectively, which are relatively large compared with other Mi values in this model, it is necessary to correct the MI of e3-e11, e9-e18, e10 -e29 and e18-e28 in this model, release the MI value and adopt the correlation between residuals. Although it is generally not allowed to eliminate Mi value by correlation between residuals of cross latent variables in the MI correction standard, the elimination of MI value between cross dimensions in this model can be explained. The explanations of e3-e11 are as follows: from question 3 of the scale (how accurate is the analysis of big data used by jd.com's intelligent shopping solution for unmanned convenience stores?) and question 11 (how accurate is the analysis of big data used by jd.com's intelligent shopping solution for X intelligent unmanned supermarkets?), we found that the two questions are both jd.com's big data although they correspond to different retail stores, so we released e3-e11. In question 9 (convenience of entering and leaving the store of JDX intelligent unmanned supermarket intelligent shopping solution?) and question 18 (convenience of entering and leaving the store of TaoCoffee intelligent unmanned store intelligent shopping solution?) of the scale, it was found that the intelligent shopping solutions of intelligent unmanned stores of retail enterprises with two questions used gate equipment to manage the entrance and exit of unmanned stores, so e9-e18 was released. The same interpretation applies to e18-e28. From the corresponding topics of E10 and E29, respectively, "is it easy to register new users for JDX intelligent supermarket intelligent shopping solution?" and "is it easy to register new users for Amazon Go intelligent shopping solution?" it can be found that although their corresponding retail enterprises are different, they are registered through apps, so e10-e29 is released. The final model fitting process and results are shown in the figure below:

Table 5.9 Model Fitness Test One

Index	Reference standards	Initial model fitting index	Initial model evaluation	Final model fitting index	Final model evaluation
CMIN/DF	1-3 is excellent, 3-5 is good	2.112	Excellent	1.949	Acceptable
RMSEA	<0.05 is excellent, <0.08 is good	0.06	Good	0.055	Acceptable
SRMR	<0.05	0.04	Acceptable	0.0386	Acceptable
IFI	>0.9 is excellent , >0.8 is good	0.912	Excellent	0.926	Acceptable
TLI	>0.9 is excellent , >0.8 is good	0.906	Excellent	0.920	Acceptable
CFI	>0.9 is excellent , >0.8 is good	0.912	Excellent	0.925	Acceptable
PNFI	>0.5	0.794	Acceptable	0.766	Acceptable
PCFI	>0.5	0.856	Acceptable	0.842	Acceptable

Through the above Mi correction method, the relevant indicators of the scale are modified to reach the ideal value, and the confirmatory analysis of the scale meets the design requirements.

5.4. Summary of This Section

To sum up, the design goal of the scale is finally achieved through the production of the scale, the data collection of the scale, the frequency analysis of the basic information of the scale, the reliability analysis, the discrimination analysis of the scale, the exploratory factor analysis, and the confirmatory factor analysis. Since the content of the scale was not deleted during the analysis, the content of the scale is still the original design, and the specific content of the scale is described in the above chapters.

Chapter 6 – Reconstruction Strategy

6.1. Analysis of Evaluation Data

Through grounded theory, we have a deep understanding of the factors that affect the intelligent shopping solutions of retail enterprises' intelligent unmanned stores. Based on the results of grounded theory, we designed the Likert scale and constructed the customer evaluation system of intelligent shopping solutions for retail enterprises' intelligent unmanned stores. Through the investigation of the scale of the customer evaluation system of intelligent shopping solutions for retail enterprises' intelligent unmanned stores, we obtained the customer evaluation data. Through the reliability, descriptive analysis, item analysis, exploratory factor analysis, confirmatory factor analysis and other methods, we rigorously and orderly verified the structure and data accuracy of the scale, and finally obtained the customer evaluation system model of intelligent shopping solutions for retail enterprises' intelligent unmanned stores. Through the analysis of the above obtained customer evaluation system data of intelligent shopping solutions for retail enterprises' intelligent unmanned stores, we can also obtain the factors with high customer evaluation scores in all aspects of intelligent shopping solutions for retail enterprises' intelligent unmanned stores, and use these factors to rebuild the intelligent shopping solutions for retail enterprises' intelligent unmanned stores. Before building an intelligent shopping solution, it is necessary to establish virtual nodes for shopping links, conduct specific analysis with these nodes, and finally integrate all links. The specific contents are as follows:

6.1.1. Store Entry Data Analysis

By sorting out the store entry data of the intelligent shopping solution for retail enterprises' intelligent unmanned stores, the average value of the evaluation score data of retail enterprises' entering stores is obtained, as shown in the following figure:

Table 6.1   Intelligent Shopping Solution Enter The Store Average Value Data Table

Code	Average Score	Description
JD01	3.911	
JDX09	3.959	Convenience of customers entering and exiting the store
TKF18	3.838	
AZG28	3.848	
JD02	3.632	
JDX10	3.711	The registration process for new users is simple
TKF19	3.625	
AZG29	3.663	
JD03	3.822	
JDX11	3.854	Security guarantee
TKF20	3.825	
AZG30	3.724	

From the above table, we can see that the intelligent shopping solution mainly includes three theme items: convenience of customers entering the store, complexity of new user registration and security guarantee. Among them, JDX intelligent unmanned supermarket JDX09 scored an average of 3.959 for the convenience of entering the store, with the highest average score. It shows that most customers recognize the convenience of entering JDX intelligent unmanned supermarket. The functions of JDX intelligent unmanned store to enter the store mainly include the following aspects: easy to understand and clear shopping guide, convenient payment for new users, fluency of customers entering the store, and face recognition authentication. Before customers enter the store, the guide map and operation instructions are posted at the door of the store, which are clear and easy to understand. Unlike the unmanned convenience store, the unmanned supermarket uses JD app to bind payment information, and can use JD app or JD applet to open secret free payment. Get the QR code on JD app, scan the code on the gate to enter the unmanned supermarket. Registered users are not required to register in JD intelligent supermarket in the future. Registered users can also scan their faces and directly enter the unmanned supermarket through the gate.

In terms of simplification of new user registration, JDX intelligent unmanned supermarket jdx10 obtained the highest average score of 3.711, indicating that customers are quite satisfied with the simplification of new user registration of JDX unmanned convenience store. New users can download JD app to register or register in wechat applet, record face information and verify identity.

In terms of security protection, JDX intelligent unmanned supermarket JDX11 scored the highest score with an average score of 3.854. Customers think that installing gate access control equipment at the entrance of the supermarket can ensure the entry of legitimate users and play a role in customer identity filtering.

There are other personalized requirements in the process of entering the store, such as the customer login method and exception information processing. These requirements can be included in other functions, such as the user is already logged in after registration, and the exception processing before the user enters the gate can be reflected in the security guarantee.

6.1.2. Intelligent Shopping Data Analysis

By sorting out the intelligent shopping data of the intelligent shopping solution of the retail enterprise intelligent unmanned store, the average value of the evaluation score data of the retail enterprise intelligent shopping store is obtained, as shown in the table below:

Elaboration by the author

Table 6.2 Intelligent Shopping Solution Intelligent Shopping Average Value Table

Code	Average Value	Description
JD04	3.854	
JDX12	3.927	Accuracy of big data analysis
TKF21	3.892	
AZG31	3.790	
JD05	3.873	
JDX13	3.930	Computer vision recognition accuracy
TKF22	3.892	
AZG32	3.835	
TKF23	3.759	Speech recognition accuracy
AZG33	3.756	

It can be seen from the above table that the intelligent shopping link of the intelligent shopping solution mainly includes three subject items: the accuracy of big data analysis, the accuracy of computer vision recognition, and the accuracy of speech recognition. Among them, JD intelligent unmanned store jdx12 scored an average of 3.927 for the accuracy of big data, with the highest average score, indicating that most customers agree with the accuracy of big data analysis of JDX intelligent unmanned store. JD big data plays two major roles in JDX intelligent unmanned store, the first is user habit data analysis, and the second is user shopping data analysis. The analysis of user habit data mainly includes the analysis of customer action trajectory, the statistical analysis of customer incoming passenger flow, the analysis of customer passenger flow distribution, the analysis of customer basic attributes, the analysis of customer preferences, etc. User shopping data analysis mainly includes customer identity, customer shopping location, customer shopping action, customer shopping goods, customer shopping goods status, etc. The above data analysis is usually combined with image recognition technology, accompanied by big data image search and distributed cloud computing.

In terms of the accuracy of computer vision recognition, JDX intelligent unmanned store JDX13 got an average score of 3.93, with the highest average score, indicating that most customers recognize the computer vision recognition of JDX intelligent unmanned store. JDX intelligent unmanned store is equipped with ten cameras, which can not only monitor customers' behavior inside the supermarket through computer vision, It can also analyze and record customers' shopping preferences. Including: customers' walking track, total length of stay in the store, length of stay in front of a shelf or goods, identification of customers' physical behavior, ability to identify the number of goods purchased by customers, and convenience for retailers to identify, scan and calculate goods such as timely replenishment and display, the main way is to use the combination of RFID and image recognition.

In terms of speech recognition accuracy, only TaoCoffee intelligent unmanned store and Amazon Go intelligent unmanned convenience store use speech recognition technology. After the evaluation of the above two, TaoCoffee intelligent unmanned store TKF23 obtained an average score of 3.759, with the highest average score. After completing the recognition and matching of Taobao's face and account number,

the customers of the "Tao coffee" intelligent unmanned store can order at the fresh food and tea processing counter. The customers will say what they want to order in front of a camera "waiter" that can recognize the face. The voice will be captured by the voice recognition system, and the menu will be automatically generated and the order will be placed. Then they will ask whether they need to pay. If they answer "confirm", they will automatically deduct money from their Alipay account.

6.1.3. Intelligent Settlement and Check-out Data Analysis

By sorting out the intelligent settlement and outlet data of the intelligent shopping solution for retail enterprises' intelligent unmanned stores, the average value of the evaluation score data of retail enterprises' intelligent settlement and outlet is obtained, as shown in the following figure:

Elaboration by the author

Table 6.3 Intelligent Shopping Solution Intelligent Settlement Average Value Table

Code	Average Value	Description
JDX14	3.987	
TKF24	3.895	RFID technology accuracy
AZG34	3.806	
JD06	3.990	
JDX15	3.914	
TKF25	3.905	The use of mobile payment technology
AZG35	3.870	
JD07	3.714	
JDX16	3.775	Risk resistance and fault tolerance in
TKF26	3.730	shopping
AZG36	3.692	
JD08	3.860	
JDX17	3.933	Accuracy and timeliness of settlement
TKF27	3.857	feedback
AZG37	3.822	

From the above table, we can see that the intelligent settlement of intelligent shopping solutions mainly includes four subject items: the accuracy of RFID technology, the use of mobile payment technology, shopping risk resistance and fault tolerance, and the accuracy and timeliness of settlement feedback. In terms of the

accuracy of RFID technology, JDX intelligent unmanned supermarket JDX14 got an average score of 3.987, with the highest average score, indicating that the accuracy of JDX intelligent unmanned supermarket RFID technology has been recognized by customers. The use of RFID technology in JDX intelligent unmanned supermarket mainly includes two parts. The first part is to paste the RFID tag on the commodity, that is, before the commodity is sold, the background operator initializes the RFID tag and pastes it on the commodity package. The second part is the 360 degree contactless identification of RFID tags of commodities during commodity settlement. When shopping in JD unmanned supermarket, you can put goods in your pocket, schoolbag, handbag and other places, and then directly walk out of the gate.

In terms of the accuracy of mobile payment, JD intelligent unmanned convenience store jd06 got an average score of 3.99, with the highest average score. Customers recognized the accuracy of JD intelligent unmanned convenience store's mobile payment technology. JD intelligent unmanned convenience store mobile payment technology mainly uses biometric technology as the carrier, and face recognition triggers the use of mobile payment technology to complete the settlement of shopping goods. Customers bind jd.com accounts on jd.com app and configure secret free payment to complete shopping settlement without perception. Customers do not queue up when leaving the store, which is convenient for users to leave the store.

In terms of shopping risk resistance and fault tolerance, JDX intelligent unmanned supermarket JDX16 got an average score of 3.775, with the highest average score. Customers recognized the shopping risk resistance and fault tolerance of JDX intelligent unmanned supermarket. Although the cost of large-scale use of RFID tags is high, the induction rate in thunderstorms and liquid tanks will be reduced, the tags will not be recognized if they are tightly held or pinched, and the goods with special materials such as glass will not be recognized. Sometimes, the loss of commodity tags and the destruction of tags will not be recognized, but the accuracy of using RFID at this stage is still relatively high. The accuracy of jd.com multimodal face detection algorithm for human recognition is 99.8%.

In terms of accuracy and timeliness of settlement feedback, JDX intelligent unmanned supermarket JDX17 got an average score of 3.933, with the highest average score. Customers recognized the accuracy and timeliness of settlement

feedback of JDX intelligent unmanned supermarket. After leaving JDX intelligent unmanned supermarket, JD app timely pushed the settlement message to notify customers, without delay, and customers checked the settlement information accurately.

To sum up, by analyzing the average value of the items of the intelligent shopping solution for the intelligent unmanned store, the average highest score of each item is obtained, as shown in the table below:

Elaboration by the author

Table 6.4 Intelligent Shopping Solution Intelligent Highest Average Value Table

Code	Average Score	Description
JDX09	3.959	Convenience of customers entering and exiting the store
JDX10	3.711	The registration process for new users is simple
JDX11	3.854	Security guarantee
JDX12	3.927	Accuracy of big data analysis
JDX13	3.93	Computer vision recognition accuracy
TKF23	3.759	Speech recognition accuracy
JDX14	3.987	RFID technology accuracy
JD06	3.99	The use of mobile payment technology
JDX16	3.775	Risk resistance and fault tolerance in shopping
JDX17	3.933	Accuracy and timeliness of settlement feedback

The highest score of each item of the intelligent shopping solution is shown below:

Figure 6.1 The highest score chart for each question of the intelligent shopping solution

6.2. Intelligent Shopping Solution Reconstruction

From the analysis results of the evaluation data, I obtained the item with the highest average score of each item in the intelligent shopping solution of the intelligent unmanned store, and made a brief description. Next, we will reconstruct the intelligent shopping solution of the intelligent unmanned store according to the analysis results, and the details are as follows:

6.2.1. Enter The Store Reconstruction

In the aspect of entering the store, the solution of JDX intelligent unmanned supermarket is adopted in three aspects: the convenience of customers entering and leaving the store, the simplification of new user registration process, and the security guarantee. According to the intelligent shopping solution of JDX intelligent unmanned supermarket, the solution of customers entering the store is summarized. Before entering the store, customers in the intelligent unmanned store first need to view the guidance information map, confirm the steps and processes of entering the store, and then start the steps of entering the store. The customer checks whether he is a new user of the merchant app and has entered the unmanned store for the first time. If he is a new user and has entered the unmanned store for the first time, the customer will open the merchant app to scan the QR code posted outside the store, open the QR code link, enter the face information according to the prompt information, generate the QR code with the merchant app, and scan the QR code on the gate system. The gate system will identify the user. If you is a normal user, you can enter the store through the gate. If the customer of JD intelligent x unmanned store is a registered user, he/she will directly brush his/her face and prepare to enter the unmanned store through the gate. Before entering the unmanned store, he/she also needs to check whether there are unpaid orders. If there are, he/she needs to pay the last unpaid order first. After payment, he/she can enter the store through the gate.
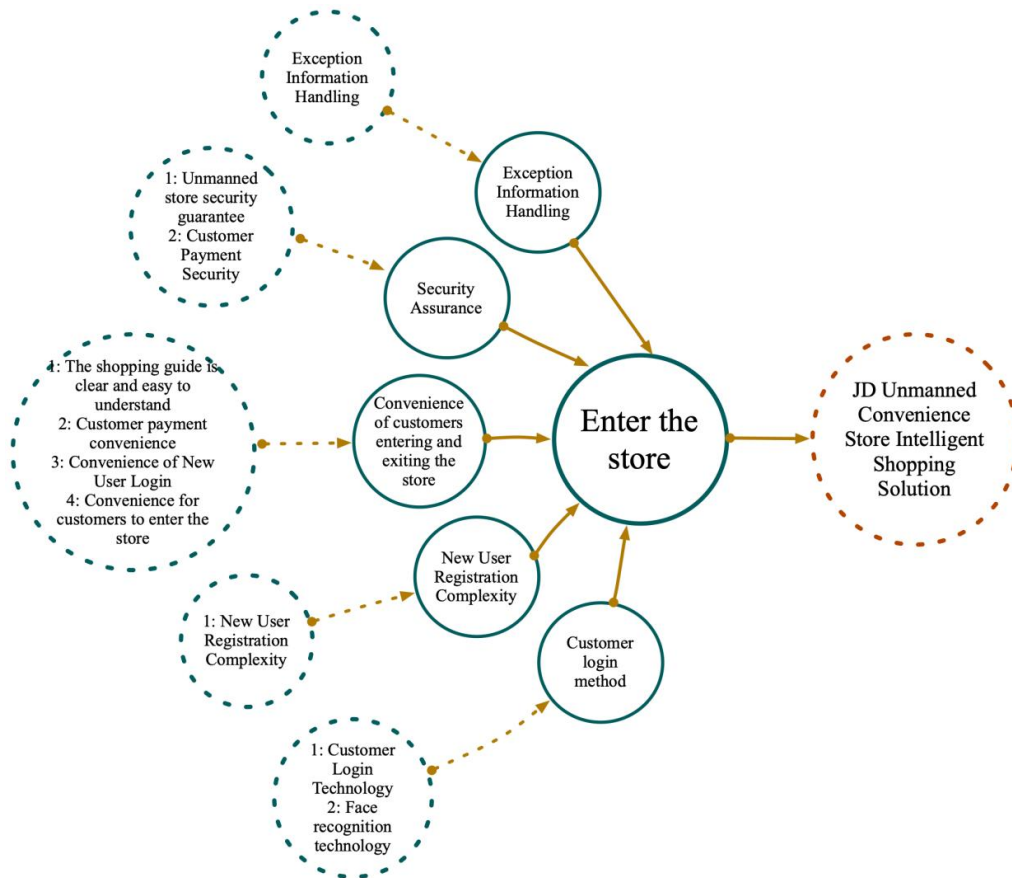
Figure 6.2 Store entry reconstruction function diagram

6.2.2. Intelligent Shopping Reconstruction

In the aspect of intelligent shopping, the solutions of JDX intelligent unmanned supermarket and TaoCoffee intelligent unmanned store are adopted in three aspects: the accuracy of big data analysis, the accuracy of computer vision recognition and the accuracy of speech recognition, and the solutions of intelligent shopping are summarized. The customers in the intelligent unmanned store arrive at the designated payment channel, and the payment channel is a distance from the exit. When the customers carry the goods to the end of the payment channel, the RFID identification system will automatically identify the goods carried by the customers. When arriving at the exit, the face recognition system on the large screen will automatically recognize the customer's identity and add the product information to the customer's merchant app. At this time, it is also necessary to use the process of comparing the computer vision shopping list with the RFID identification shopping list. If any inconsistency

is found, the operator will be reminded in the operation monitoring background, and the operator will handle it through after-sales service. Because the secret free payment is opened when entering the store for registration, the whole settlement process does not need to take out the mobile phone for additional operations, and you can go out from the payment settlement channel. As face recognition is required during settlement, the former customer leaves the channel and the next customer enters the channel for settlement. After completing the recognition and matching of face and account number, the customers in the intelligent unmanned store can order at the fresh food and tea processing counter. The customers say the food they want to order in front of the "waiter" standing in front of a camera that can recognize the face. The voice will be captured by the voice recognition system, and the menu will be automatically generated and the order will be placed. Then they will ask whether they need to pay, and answer "confirm", and the payment will be automatically deducted from the merchant app account.

Elaboration by the author
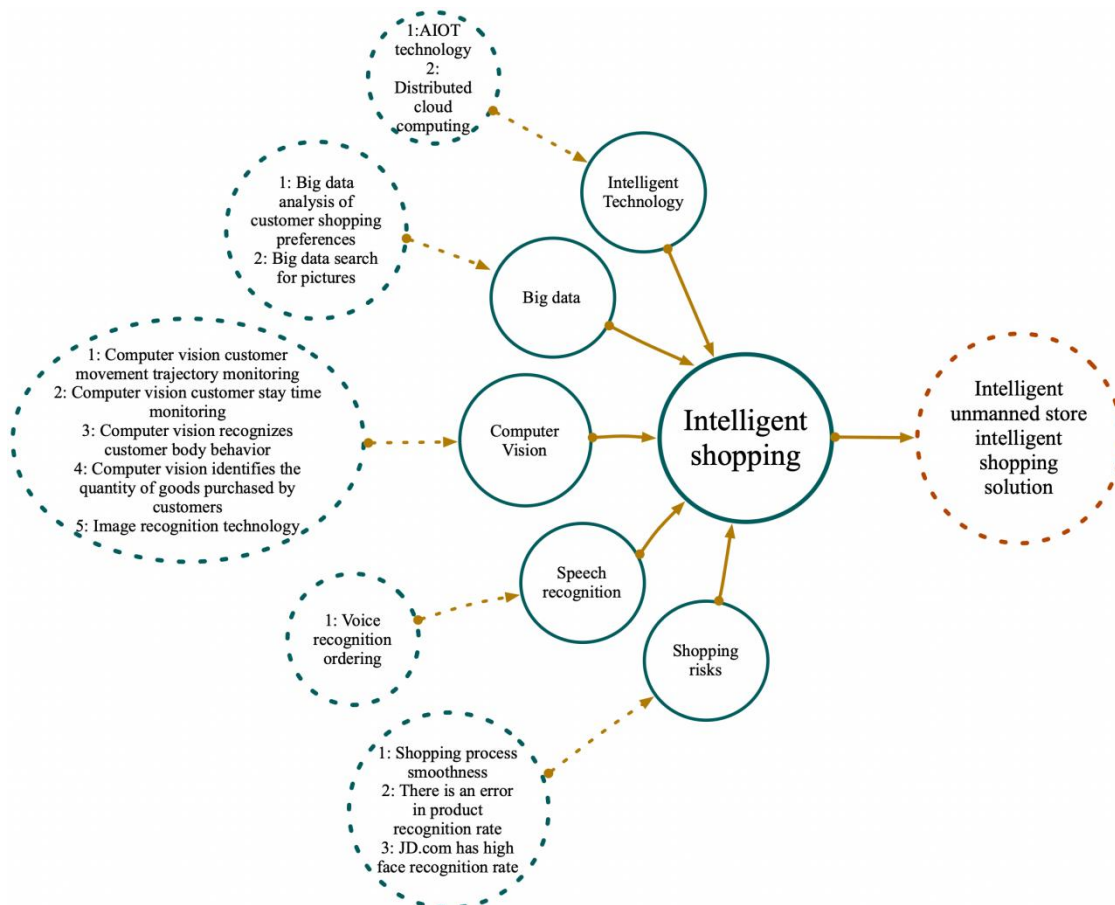
Figure 6.3 Intelligent shopping reconstruction function diagram

6.2.3. Intelligent Settlement Reconstruction

In the aspect of intelligent settlement, the solutions of JD intelligent unmanned convenience store and JDX intelligent unmanned supermarket are adopted in four aspects: the accuracy of RFID technology, the accuracy of mobile payment technology, the anti risk and fault tolerance of shopping, the accuracy and timeliness of settlement feedback, and the solutions of intelligent settlement are summarized. Commodity RFID identification technology and commodity intelligent identification technology are two major technical systems of intelligent shopping solutions for intelligent unmanned stores. They can be used separately or in a mixed way. In order to ensure the accuracy of identification, mixed use is generally used. The hybrid technology used in JDX unmanned supermarket. The customers in the intelligent unmanned store arrive at the designated payment channel, and the payment channel is a distance from the exit. When the customers carry the goods to the end of the payment channel, the RFID identification system will automatically identify the goods carried by the customers. When arriving at the exit, the face recognition system on the large screen will automatically recognize the customer's identity and add the product information to the customer's merchant app. At this time, it is also necessary to use the process of comparing the computer vision shopping list with the RFID identification shopping list. If any inconsistency is found, the operator will be reminded in the operation monitoring background, and the operator will handle it through after-sales service. Because the secret free payment is opened when entering the store for registration, the whole settlement process does not need to take out the mobile phone for additional operations, and you can go out from the payment settlement channel. Because face recognition is required during settlement, the former customer leaves the channel and the next customer enters the channel for settlement.

Elaboration by the author

92
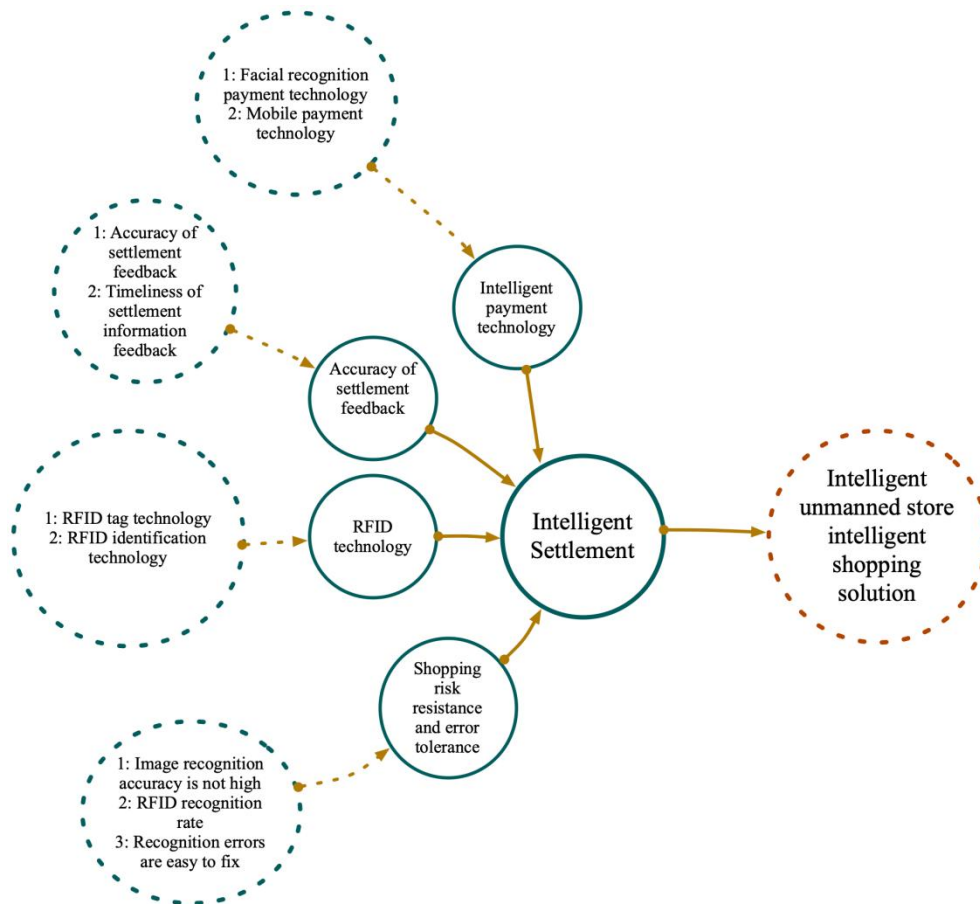
Figure 6.4 Intelligent settlement reconstruction function diagram

Based on the above, the flow chart of intelligent shopping solution for intelligent unmanned store is summarized as follows:

Elaboration by the author
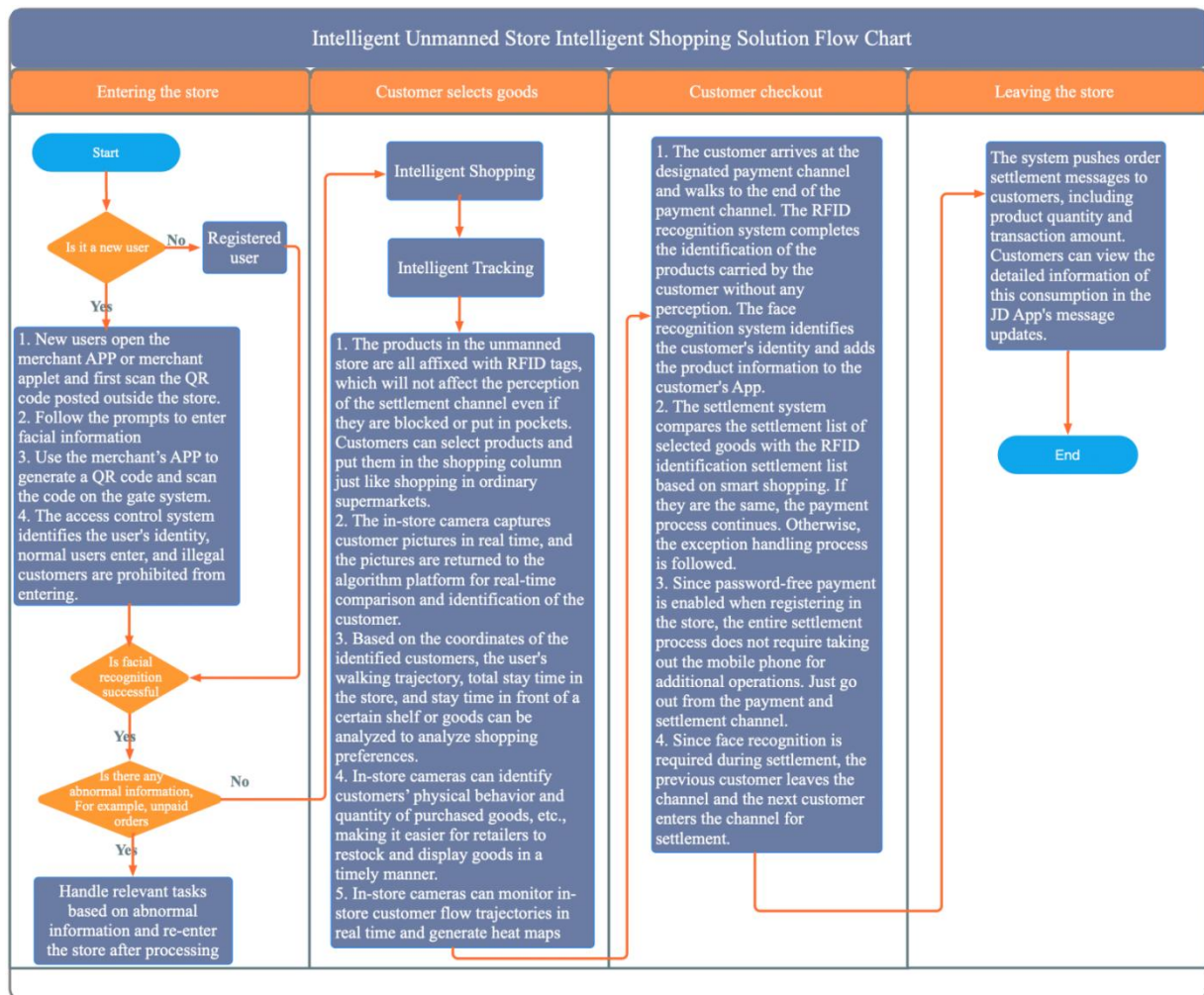
Figure 6.5 Intelligent unmanned store intelligent shopping solution flow chart

6.3. Summary of This Section

By analyzing the customer evaluation data of the intelligent shopping solution of the intelligent unmanned store, we can get the items with the highest average score, and then reconstruct these items to get a new intelligent shopping solution of the intelligent unmanned store.

Chapter 7 – Conclusion and Recommendations

7.1. Conclusion

Through literature research, customer interviews, coupon surveys, grounded theory, statistical analysis and other qualitative and quantitative analysis methods, this study studies the intelligent shopping solutions of retail enterprises' intelligent unmanned stores, and answers the questions raised at the beginning of the study.

1. Through research on Google academic papers, CNKI papers, journal literature, and online media articles, relevant concepts and brief backgrounds such as new retail, intelligent unmanned stores, customer experience, artificial intelligence, big data, mobile payment, AIOT, etc. were cited and summarized, laying the foundation for other research in this dissertation.

2. This dissertation elaborates on the progress of research on intelligent unmanned store and intelligent shopping solutions by various enterprises through literature review and literature review. From the current research status of intelligent unmanned stores abroad, Zippin and Amazon Go are the main representatives. In terms of technology, AIOT, deep learning, neural networks, intelligent payments, biometric recognition, image recognition, facial recognition, big data analysis and other technologies are mainly used. Although these technologies are mature, there are certain errors in the accuracy of product recognition, facial recognition, intelligent tracking and other aspects, This part of the error is also one of the reasons why the promotion of intelligent shopping solutions cannot be increased. Due to this part of the error, it also leads to an increase in research and development costs and maintenance costs, resulting in an increase in the cost of the entire intelligent unmanned store. The same issues apply in China.

3. In order to establish a customer evaluation system for intelligent shopping solutions of intelligent unmanned stores, it is necessary to first find out the factors that affect the intelligent shopping solutions of intelligent unmanned stores, and then abstract these factors into questions that customers can understand. This study uses grounded theory to analyze 41 original sample data of more than 120000 words, and obtains the three-level code of the intelligent shopping solution of JD intelligent unmanned convenience store, JDX intelligent unmanned supermarket, Alibaba "TaoCoffee" intelligent unmanned supermarket and Amazon Go intelligent unmanned convenience store, Thus, the factors that affect the intelligent

shopping solutions of retail enterprises' intelligent unmanned stores and the factors that affect the intelligent shopping solutions of general intelligent unmanned stores are obtained. The main contents include: the convenience of customers entering and leaving the store, the complexity of new user registration, customer login mode, security assurance, abnormal information processing, big data, computer vision, in-depth learning, intelligent shelf, shopping convenience, intelligent added goods, voice recognition, intelligent technology, intelligent sensor, tally system, shopping risk, intelligent settlement desk, RFID technology, intelligent settlement, intelligent payment technology Shopping Risk and fault tolerance, accuracy and timeliness of settlement feedback.

4. According to the content of the factors affecting the intelligent shopping solution of the intelligent unmanned store, the customer experience evaluation items of the intelligent shopping solution of the intelligent unmanned store are established, and the Likert matrix scale is established for these items. The content of the scale was evaluated and the data were obtained through interviews and online surveys, and then the reliability analysis, reliability analysis, exploratory factor analysis and confirmatory factor analysis were carried out on the data. Finally, the customer experience evaluation system of intelligent shopping solutions for intelligent unmanned stores and the average score of each item were developed, which established the conditions for the reconstruction of intelligent shopping solutions for intelligent unmanned stores.

5. Through the average score of each item, the factors that customers think have the highest average score of intelligent shopping solutions for intelligent unattended stores are obtained, and then these factors and the corresponding functions of these factors are reorganized to obtain the latest intelligent shopping solutions.

7.2. Limitations

According to the analysis of the above conclusions, this study has certain limitations: 1. The process of extracting concepts through grounded theory may be subjective. It is impossible to guarantee that the interviewer is not subjective, and since there is no joint coding by multiple experts, there is no guarantee that the coders are not subjective. 2. It is difficult to obtain sample data. There are very few customers who have used four intelligent unmanned stores at the same time. Therefore, we choose at least the employees and high-quality people of the above three enterprises as research objects, and obtain data through wechat colleague group and network research. For researchers who have not worked in the

above three companies, have not participated in the development of intelligent unmanned stores, and do not understand the technology, it is difficult to obtain reliable sample data. 3. The sample data may be subjective, and for the employees of the company, the evaluation of the intelligent unmanned store of the company may be biased. 4.the sample data is relatively small, there may be results error. 5. In the absence of innovative technologies, customers may choose technologies with high commodity recognition rate as the main technical solution of smart shopping solutions, such as RFID technology, but this is not what this study wants to see.

7.3. Recommendations

According to the above analysis of the sample data, JD intelligent unmanned store, Ali intelligent unmanned store and Amazon intelligent unmanned store have achieved great success in terms of strategy, science, technology, intelligence, financial concept and customer shopping convenience, although there is a certain increase in technical maintenance costs. But the increase in maintenance costs relative to other benefits is worth it. The development of science and technology is inseparable from the development of business, science and technology need to be business-driven, and intelligent unmanned stores are very good business-driven scenarios.

Through understanding the limitations of this study, when using grounded theory coding, we should invite multiple experts to code together to reduce subjective coding. When conducting research, it is more likely to increase the sample data.

In terms of technological innovation, due to the relatively low recognition rate of computer vision and sensor fusion technology, it does not achieve the expected purpose, and businesses will still choose RFID technology with high recognition rate and high cost when choosing technology. In the existing technology, whether it is multi-modal recognition, deep learning algorithms, big data analysis and other technologies, can not make the accuracy of goods and people, goods and people match 100%, in order to normalize the business, we must improve the quality of people. At present, the technology of commodity recognition includes bone recognition analysis and quantum recognition analysis. Quantum recognition analysis is the only way to technological innovation, the above technology, if conditions permit, you can try to study it.

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Annex A:Customer Experience Evaluation Questionnaire

Part 1: Subject Selection

1. Have you ever used the following intelligent unmanned store for shopping [multiple choice question]* □ JDX Unmanned Supermarket □ JD Unmanned Convenience Store □ Alibaba's "TaoCoffee" intelligent unmanned store □ Amazon Go Unmanned Store □ Other □ You can directly exit the questionnaire if you have never used it before Select the 'Never Used' option to end the questionnaire. Select other options and jump to the next question.

Part 2: Research on the Customer Experience of Intelligent Unmanned Stores and Intelligent Shopping

Table 5.1 Customer experience problems of intelligent shopping in intelligent unmanned stores

NO	Questions	Very dissatisfied	Dissatisfied	Average	Satisfied	Very satisfied
		1	2	3	4	5
2	JD Unmanned Convenience Store Intelligent Unmanned Store Intelligent Shopping Solution Customer Experience Evaluation? [Matrix Scale Question]					
JD-01	JD Convenience of customers entering and exiting the store					
JD-02	JD The registration process for new users is simple					
JD-03	JD Security guarantee					
JD-04	JD Accuracy of big data analysis					
JD-05	JD Computer vision recognition accuracy					
JD-06	JD The use of mobile payment technology					
JD-07	JD Risk resistance and fault tolerance in shopping					
JD-08	JD Accuracy and timeliness of settlement feedback					
3	Customer Experience Evaluation of JDX Unmanned Supermarket Intelligent Shopping Solution? [Matrix Scale Question]*					
JDX-09	JDX Convenience of customers entering and exiting the store					
JDX-10	JDX The registration process for new users is simple					

JDX-11	JDX Security guarantee					
JDX-12	JDX Accuracy of big data analysis					
JDX-13	JDX Computer vision recognition accuracy					
JDX-14	JDX RFID technology accuracy					
JDX-15	JDX The use of mobile payment technology					
JDX-16	JDX Risk resistance and fault tolerance in shopping					
JDX-17	JDX Accuracy and timeliness of settlement feedback					
4	Customer experience evaluation of Alibaba's "TaoCoffee" intelligent unmanned store intelligent shopping solution? [Matrix Scale Question]*					
TKF-18	TKF Convenience of customers entering and exiting the store					
TKF-19	TKF The registration process for new users is simple					
TKF-20	TKF Security guarantee					
TKF-21	TKF Accuracy of big data analysis					
TKF-22	TKF Computer vision recognition accuracy					
TKF-23	TKF Speech recognition accuracy					
TKF-24	TKF RFID technology accuracy					
TKF-25	TKF The use of mobile payment technology					
TKF-26	TKF Risk resistance and fault tolerance in shopping					
TKF-27	TKF Accuracy and timeliness of settlement feedback					
5	Amazon Go Intelligent Unmanned Convenience Store Intelligent Shopping Solution Customer Experience Evaluation? [Matrix Scale Question]*					
AZG-28	AZG Convenience of customers entering and exiting the store					
AZG-29	AZG The registration process for new users is simple					
AZG-30	AZG Security guarantee					
AZG-31	AZG Accuracy of big data analysis					
AZG-32	AZG Computer vision recognition accuracy					
AZG-33	AZG Speech recognition accuracy					
AZG-34	AZG RFID technology accuracy					
AZG-35	AZG The use of mobile payment technology					
AZG-36	AZG Risk resistance and fault tolerance in shopping					
AZG-37	AZG Accuracy and timeliness of settlement feedback					

Part 3: Basic Information of the Subject

6. What is your gender? [Multiple choice question]*
○ Male

○ Female

7. What is your highest education level? [Multiple choice question]*

○ High school, technical secondary school and below (including ongoing studies)

○ Junior college and undergraduate studies (including ongoing studies)

○ Master's degree or above (including ongoing studies)

Annex B:Open Codes

Table 4.2 Table of open codes

Shopping nodes	Conceptual abstraction	Subcategory extraction
JD Intelligence Unmanned convenience store		
Enter the store	a1: Clear guidance information a2: The guidance information is simple and easy to understand	A1: The shopping guide is clear and easy to understand
	a3: activate password free payment a4: Customers bind JD accounts on JD Me	A2: Customer payment convenience
	a5: Registered customers do not need to register, directly face recognition opens the door	A2: Customer payment convenience
	a6: When the door is closed, facial recognition opens the door, and all customers enter without opening the door after opening the door	A4: Convenient for customers to enter the store
	a7: Customer Personal Information Entry a8: Facial information input	A5: New User Registration Complexity
	a9: Biometrics	A6: Customer login technology
	a10: Face recognition login	A7: Face recognition technology
	a11: Install access control system at the entrance of convenience stores	A8: Safety Assurance for Unmanned Supermarkets
	a12: Confidentiality free payment is not associated with online JD aPP consumption a13: Clear payment feedback	A9: Customer Payment Security
	a14: are there any unpaid orders	A10: Exception Information Handling
Intelligent shopping	b1: Flow funnel entry rate detection b2: Traffic funnel statistics passenger flow data b3: big Data analysis of basic Customer attributes	B1: Big Data Analysis of Flow Funnel

b4: Provide data support for offline refined operations b5: Provide data-driven references for operators to select products and tally goods	B2: Refined operational data support
b6: Generate a passenger flow heat map. b7: Passenger flow density statistics	B3: Big data analysis and display of thermal maps
b8: big Data Image Search	B4: Big Data Image Search
b9: Computer vision recognition of customer identity b10: Perception camera monitors the passenger flow trajectory inside the store b11: Computer Vision	B5: Computer vision customer action trajectory monitoring
b12: Computer vision recognition of product display images	B6: Computer vision recognition of product display images
b13: Low cost of intelligent shelves	B7: Low cost of intelligent shelves
b14: Intelligent shelf judgment of shelf product status b15: Intelligent Shelf Replenishment Reminder b16: Supervision of intelligent shelf display b17: Intelligent Shelf Price Management b18: intelligent Shelf Promotion Management b19: Intelligent shelf intelligent push	B8: Intelligent Shelf Operation Management
b20: AIOT technology uploads current product status information, etc b21: AIOT technology	B9: AIOT Upload Data
b22: Convolutional Neural Network	B10: Deep Learning
b23: Distributed Cloud Computing	B11: Distributed Cloud Computing
b24: edge computing User ID and Product ID Match b25: edge computing: matching the display picture at the edge with the label picture	B12: edge computing
b26: Intelligent sensor edge computing identifies changes in commodity status	B3: Intelligent sensor edge computing identifies changes in commodity status
b27: Intelligent sensors perceive changes in goods b28: Customer and purchased product binding	B14: Intelligent Sensors
b29: The tally system automatically identifies the display and decoration of goods b30: The tally system automatically identifies the brand exposure of the product b31: The tally system automatically recognizes the quantity status of goods	B15: Intelligent identification of tally system
b32: The tally system automatically prompts the store owner to tally and replenish goods b33: Display irregularity prompt	B16: Intelligent prompt of tally system

	b34: The tally system reduces labor costs by improving human efficiency b35: The tally system helps merchants save brand display costs	B17: Reducing operational costs through the tally system
	b36: Digital Operations	B18: Digital Operations
	b37: Take it and go, convenient and fast b38: The shopping process is not smooth b39: No guide, no product found	B19: Smooth shopping process
	b40: Error in product recognition rate	B20: Error in product recognition rate
	b41: JD has a high facial recognition rate	B21: JD has a high facial recognition rate
Intelligent settlement	c1: Intelligent shelves perceive customer behavior, perceive the products they are shopping for, and the perception system will display the purchased products and deduct payments c2: Weighing at the settlement desk c3: Payment at settlement desk	C1: Intelligent settlement platform payment C2: Intelligent settlement platform weighing C3: Computer vision recognition of goods at the settlement desk
	c4: The intelligent settlement platform uses AIOT to upload customer, product weight, and price information	C4: Intelligent settlement platform AIOT uploads customer and product information
	c5: The intelligent settlement platform has product identification and signing functions	C5: The intelligent settlement platform has product identification and signing functions
	c6: Low cost of intelligent settlement desk	C6: Low cost of intelligent settlement platform
	c7: Mobile Payment Technology	C7: Mobile Payment Technology
	c8: Using visual recognition technology to identify products and then "swipe" payment;	C8: Face recognition payment technology
	c9: High accuracy of product identification c10: Some products require RFID assistance c11: Product identification error easy to fix	C9: Low overall recognition accuracy C10: Partial product RFID assistance C11: Easy to fix recognition errors
Leave the store	d1: Clear content of electronic shopping list	D1: Accuracy of settlement feedback
	d2: Timely delivery and push of electronic shopping lists	D2: Timeliness of settlement information feedback
JDX Intelligent Unmanned Supermarket		
Enter the store	e1: Clear guidance information e2: The guidance information is simple and easy to understand	E1: Easy to understand and clear shopping guide
	e3: JD APP binding payment information e4: For the first time entering the store, JD Mall mini program opens WeChat password free payment	E2: Convenience of payment for new users

	e5: WeChat mini program scanning code to enter the store e6: Obtain QR code on JD APP e7: Registered customers still need to scan the code to enter the store e8: Scan QR code on the gate to enter the store e9: Registered customers do not need to register, directly face recognition gate opens the door e10: Customer Face Recognition and Access Control System Association	E3: Customer entry fluency
	e11: Face recognition and identity recognition	E4: Face recognition identity verification
	e12: Download JD APP registration and verification e13: New user enters facial information	E5: New User Registration Complexity
	e14: Install gate access control equipment at the entrance of the supermarket	E6: Safety Assurance for Unmanned Supermarkets
Intelligent shopping	f1: Intelligent camera monitoring of unmanned supermarkets f2: Intelligent camera obtains passenger's walking trajectory	F1: Computer vision customer action trajectory monitoring
	f3: Intelligent camera to obtain the total length of stay in the store f4: Intelligent camera obtains the length of stay in front of a certain shelf or goods, etc	F2: Computer vision customer stay time monitoring
	f5: Intelligent cameras can recognize customers' physical behavior, take out or put down products, etc	F3: Computer Vision Recognition of Customer Body Behavior
	f6: The intelligent camera can identify the quantity of goods purchased by customers, making it convenient for retailers to replenish and display them in a timely manner.	F4: Computer vision recognition of customer purchase quantity
	f7: Product identification adopts a combination of RfID and image recognition f8: Convolutional neural network f9: Computer Vision	F5: Image recognition technology
	f10: Intelligent camera acquisition and analysis of customer shopping preferences	F6: Big data analysis of customer shopping preferences.
	f11: Big Data Image Search	F7: Big Data Search Image
	f12: AIOT technology f13: AIOT product information upload	F8: AIOT Technology
	f14: Distributed Cloud Computing	F9: Distributed Cloud Computing
Intelligent settlement	g1: Face recognition and identity recognition settlement	G1: Face recognition identity

	g2: The product is labeled with an RFID tag g3: RFID label product recognition is not afraid of obstruction g4: RFID tag product identification is not afraid of being in the pocket	G2: RFID Label Technology
	g5: RFID technology identification label	G3: RFID identification technology
	g6: Mobile Payment Technology	G4: Mobile Payment Technology
	g7: High cost of RFID tags g8: RFID tags will reduce the induction rate in thunderstorm weather and liquid containers g9: RFID tags cannot be recognized if tightly held or pinched g10: Products made of special materials such as glass may not be recognized	G5: RFID technology risks
	g11: Error in product recognition rate	G6: Error in product recognition rate
	g12: JD has a high facial recognition rate	G7: JD has a high facial recognition rate
Leave the store	h1: Clear payment feedback h2: Clear content of electronic shopping list	H1: Settlement feedback accuracy
	h3: Timely delivery and push of electronic shopping lists	H2: Timeliness of settlement information feedback
Taobao Coffee		
Enter the store	i1: Clear guidance information i2: The guidance information is simple and easy to understand	I1: Easy to understand and clear shopping guide
	i3: Scan the exclusive QR code on Taobao APP to obtain an electronic entry code i4: Hold the electronic entry code and scan it on the gate to enter the store i5: Registered users hold electronic admission tickets and scan the code on the gate to enter the store	I2: Convenience of new users entering the store
	i6: Taobao APP is bound to Alipay account	I3: Customer payment convenience
	i7: New User Registration on Taobao APP i8: New user enters facial information	I4: New user registration complexity
	i9: install gate access control equipment at the entrance of the supermarket	I5: Security guarantee for unmanned supermarkets
	i10: Are there any unpaid orders	I6: Exception Information Handling
Intelligent shopping	j1: Touch screen desktop virtual shelf j2: Four ordinary chairs j3: Desktop screen j4: Face recognition recognition users	J1: Composition of touch screen desktop virtual shelves
	j5: Face recognition recognition users j6: Face recognition	J2: Face recognition technology

j7: Face recognition completion settlement payment j8: Face payment completed, waiting for call	J3: Face recognition payment
j9: Speech recognition completed placing order	J4: Voice recognition ordering
j10: Distributed Cloud Computing	J5: Distributed Cloud Computing
j11:360 degree identification of goods j12: Payment channel automatically senses products j13: Internet of Things	J6: Hybrid networking technology
j14: Biometric autonomous perception and learning technology	J7: Biometric Autonomous Perception and Learning Technology
j15: Automatically open customer's Taobao account j16: Automatically display product list j17: Customer selected products added to Taobao App j18: Customers can choose the delivery method j19: If you choose to deliver the goods to your doorstep, you do not need to go through the "payment door" and leave the store directly	J8: Convenience of Customer Intelligent Shopping
j20: The electronic screen in the pick-up area displays the pick-up number and remaining time	J9: Convenience of food pick-up
j21: Automatic settlement waiting for call and immediate processing system j22: Face recognition completed settlement payment j23: Face payment completed, waiting for call	J10: Composition of automatic settlement waiting for calling and processing system
j24: Customer store tracking and analysis system j25: Intelligent camera recognizes customer identity j26: Intelligent camera captures customer shelf time j27: Intelligent camera captures customers' pre shelf product selection j28: Intelligent camera captures customers' movement routes in front of the shelves	J11: Function of customer's in store tracking and analysis system
j29: Intelligent camera recognizes customer identity j30: Big Data	J12: Combining Computer Vision with Big Data to Identify Customer Identity
j31: Intelligent camera captures customers' movement routes in front of the shelves	J13: Computer Vision Recognition Action Route
j32: Intelligent camera captures customer shelf time	J14: Computer vision capture of shelf time
j33: Intelligent camera captures customers' pre shelf product selection	J15: Computer vision capture of pre shelf product selection
j34: Deep learning optimization of in-store product display	J16: Deep learning optimization of in-store product display
j35: Deep learning to adjust product optimization	J17: Deep learning product optimization
j36: Deep learning to enhance retail efficiency for merchants	J18: Deep learning to enhance retail efficiency for merchants

	j37: Expanding store size, increasing system computing power, and increasing CPU pressure j38: Error in image recognition accuracy j39: Carrying up to 50 people	J19: CPU capacity J20: Image recognition rate J21: Maximum number of passengers in the supermarket
Intelligent settlement	k1: Mobile payment	K1: Mobile payment technology
	k2: RFID tags k3: RFID automatic recognition technology	K2: RFID tags K3: RFID automatic recognition technology
	k4: one-time payment k5: Mobile Taobao APP and Alipay APP automatically synchronize settlement information	K4: Customer payment convenience
Leave the store	l1: After completing the payment, the prompt will prompt in a timely manner	L1: After completing the payment, the prompt will prompt in a timely manner
	l2: Automatic notification of settlement information within the app	L2: Settlement feedback accuracy
	l3: Timely feedback on settlement information	L3: Timeliness of settlement information feedback
Amazon Go		
Enter the store	m1: Clear guidance information m2: The guidance information is simple and easy to understand	M1: Easy to understand and clear for shopping guides
	m3: Scan QR code on handheld QR code access control system m4: Face recognition enters the store m5: Palmprint recognition enters the store	M2: Diversity of customer entry methods
	m6: New users installing Amazon Go App m7: New user registration and entering facial information m8: Obtain QR code on Amazon GoAPP	M3: New user registration complexity
	m9: Install gate access control equipment at the entrance of the supermarket	M4: Supermarket Safety Assurance
	m10: The access control system recognizes the user's identity and allows normal users to enter m11: The access control system identifies the user's identity and prohibits unauthorized users from entering	M5: Store customer identity filtering
	m12: Are there any unpaid orders or violations	M6: Exception information processing
Intelligent shopping	n1: Installing intelligent cameras in supermarkets n2: Installing microphones in supermarkets n3: Installing sensors in supermarkets	N1: Using hardware devices in supermarkets
	n4: Monitoring system identifies customer identity	N2: Computer vision recognition of customer identity
	n5: Monitoring system tracks customers and obtains action trajectory	N3: Computer Vision Obtaining Customer Action Trajectories
	n6: Intelligent camera recognizes customer shopping actions n7: Intelligent Camera Recognition Pickup Action n8: Intelligent camera recognition and return action n9: Motion capture technology	N4: Computer vision recognition of customer shopping actions

	n10: Intelligent Camera Identification of Products	N5: Computer vision recognition of goods
	n11: Image recognition technology	N6: Image recognition technology
	n12: Sensor recognition system: camera, microphone, sensor	N7: Composition of sensor recognition system
	n13: Face recognition	N8: Customer facial recognition identity
	n14: Intelligent camera recognizes customer skin color n15: Intelligent camera recognition for skin color differentiation in the same area	N9: Customer skin color recognition identity
	n16: Microphone collects sound n17: The microphone obtains the user's orientation through sound	N10: Voice Recognition Customer Location
	n18: Microphone obtains rough customer movements through sound	N11: Voice recognition customer's approximate actions
	n19: Microphone obtains customer behavior habits by receiving audio time difference n20: The microphone obtains the time spent by customers in front of the shelf by receiving audio time difference, and determines user preferences	N12: Voice recognition customer behavior habits N13: Voice recognition customer stay time N14: Big Data Analysis to Determine User Preferences
	n21: Judging the most popular products in supermarkets based on user preferences	N15: Big Data Analysis Supermarket's Most Popular Products
	n22: The pressure sensors and weighing sensors on the shelves determine whether the product has been taken away by the user n23: Weighing sensor to determine changes in product weight	N16: Pressure sensor and weighing sensor to determine the current status of the product
	n24: Sensor fusion for customer and product matching n25: Image recognition of customer identity	N17: Sensor fusion for customer and product matching
	n26: The sensor recognition system uploads shopping information to the virtual shopping basket of the Amazon GoApp on the user's phone	N18: Products automatically added to the app's virtual shopping basket
	n27: Multiple consumers taking one product at the same time may result in misjudgment n28: Consumer cheating may result in misjudgment	N19: Consumer shopping behavior misjudgment.
Intelligent settlement	o1: Customers arrive at the designated settlement area o2: The automatic settlement system will accurately calculate the quantity of goods purchased by users	O1: Automatic settlement in designated settlement area
	o3: When the customer leaves the store, they click on online payment or confidential payment	O2: When the customer leaves the store, click on online payment or password free payment
Leave the store	p1: Send transaction amount and other information to the user's mobile Amazon App	P1: Send transaction amount and other information to Amazon App

		p2: Insufficient timely feedback on settlement information	P2: Timeliness of settlement information feedback

Annex C: Axial Coding

Table 4.3 Axial coding table

Shopping nodes	Subcategory extraction	Conceptual abstraction
JD Intelligence Unmanned Convenience Store		
Enter the store	JdA1: Convenience of customers entering and exiting the store	A1: The shopping guide is clear and easy to understand A2: Customer payment convenience A3: Convenience of New User Login A4: Convenience for customers to enter the store
	JdA2: New User Registration Complexity	A5: New User Registration Complexity
	JdA3: Customer login method	A6: Customer Login Technology A7: Face recognition technology
	JdA4: Security Assurance	A8: Unmanned store security guarantee A9: Customer Payment Security
	JdA5: Exception Information Handling	A10: Exception Information Handling
Intelligent shopping	JdB1: Big Data	B1: Big Data Analysis of Flow Funnel B2: Refined operational data support B3: Big data analysis and display of thermal maps B4: Big Data Image Search
	JdB2: Computer Vision	B5: Computer vision customer action trajectory monitoring B6: Computer vision recognition of product display images
	JdB3: Intelligent Shelf	B7: Low cost of intelligent shelves B8: Intelligent Shelf Operation Management
	JdB4: Artificial Intelligence Technology	B9: AIOT Upload Data B10: Deep Learning B11: Distributed Cloud Computing B12: Edge computing
	JdB5: Intelligent Sensor	B13: Intelligent sensor edge computing recognizes the change of commodity status B14: Intelligent Sensors
	JdB6: Tallying system	B15: Intelligent identification of tally system B16: Intelligent prompt of tally system B17: Reducing operational costs through the tally system B18: Digital Operations
	JdB7: Shopping Risk	B19: Smooth shopping process B20: Error in product recognition rate B21: JD has a high facial recognition rate
	JdC1: Intelligent Settlement Platform	C1: Intelligent settlement platform payment C2: Intelligent settlement platform weighing C3: Computer vision recognition of goods at the settlement

		desk C4: Intelligent settlement platform AIOT uploads customer and product information C5: The intelligent settlement platform has product identification and signing functions C6: Low cost of intelligent settlement platform
	JdC2: Intelligent Payment Technology	C7: Mobile Payment Technology C8: Face recognition payment technology
	JdC3: Shopping Risk and Fault Tolerance	C9: Low overall recognition accuracy C10: Partial product RFID assistance C11: Easy to fix recognition errors
Leave the store	JdD1: Accuracy and timeliness of settlement feedback	D1: Accuracy of settlement feedback D2: Timeliness of settlement information feedback

JDX Intelligent Unmanned Supermarket

Enter the store	JdE1: Convenience of customers entering and exiting the store	E1: Easy to understand and clear shopping guide E2: Convenience of payment for new users E3: Customer entry fluency E4: Face recognition identity verification
	JdE2: New User Registration Complexity	E5: New User Registration Complexity
	JdE3: Safety Assurance	E6: Safety Assurance for Unmanned Supermarkets
Intelligent shopping	JdF1: Computer Vision	F1: Computer vision customer action trajectory monitoring F2: Computer vision customer stay time monitoring F3: Computer Vision Recognition of Customer Body Behavior F4: Computer vision recognition of customer purchase quantity F5: Image recognition technology
	JdF2: Big Data	F6: Big Data Analysis of Customer Shopping Preferences F7: Big Data Search Image
	JdF3: Intelligent Technology	F8: AIOT Technology F9: Distributed Cloud Computing F10: AIOT product information upload
	JdG1: Intelligent Payment Technology	G1: Face recognition payment technology G2: Mobile Payment Technology
	JdG2: RFID technology	G3: RFID tag technology G4: RFID identification technology
	JdG3: Risk of Intelligent Shopping	G5: RFID technology risks G6: Error in product recognition rate G7: JD has a high facial recognition rate
Leave the store	JdH1: Accuracy and timeliness of settlement feedback	H1: Settlement feedback accuracy H2: Timeliness of settlement information feedback

Alibaba"Tao Coffee"Unmanned Supermarket

Enter the store	AlI1: Convenience of customers entering and exiting the store	I1: Easy to understand and clear shopping guide I2: Convenience of new users entering the store I3: Customer payment convenience

	AlI2: New User Registration Complexity	I4: New user registration complexity
	AlI3: Security guarantee for unmanned supermarkets	I5: Security guarantee for unmanned supermarkets
	AlI6: Exception Information Handling	I6: Exception Information Handling
Intelligent shopping	AlJ1: Touch screen desktop virtual shelf	J1: Composition of touch screen desktop virtual shelves
	AlJ2: Intelligent Technology	J2: Face recognition technology J3: Face recognition payment J4: Voice recognition ordering J5: Distributed Cloud Computing J6: Hybrid networking technology J7: Biometric Autonomous Perception and Learning Technology
	AlJ3: Shopping convenience	J8: Convenience of Customer Intelligent Shopping J9: Convenience of food pick-up
	AlJ4: Automatic settlement waiting for call and immediate processing system	J10: Composition of automatic settlement waiting for calling and processing system
	AlJ5: Customer in store tracking and analysis system	J11: Function of customer's in store tracking and analysis system
	AlJ6: Computer Vision Recognition	J12: Combining Computer Vision with Big Data to Identify Customer Identity J13: Computer Vision Recognition Action Route J14: Computer vision capture of shelf time J15: Computer vision capture of pre shelf product selection
	AlJ7: Deep Learning	J16: Deep learning optimization of in-store product display J17: Deep learning product optimization J18: Deep learning to enhance retail efficiency for merchants
	AlJ8: Shopping Risk	J19: CPU capacity J20: Image recognition rate J21: Maximum number of passengers in the supermarket
	AlK1: Mobile Payment Technology	K1: Mobile payment technology
	AlK2: RFID technology	K2: RFID tags K3: RFID automatic recognition technology
Leave the store	AlL1: Accuracy and timeliness of settlement feedback	L1: After completing the payment, the prompt will prompt in a timely manner L2: Prompt for settlement information when leaving the supermarket L3: Timeliness of settlement information feedback
Amazon Go		
Enter the store	YmM1: Convenience of customers entering and exiting the store	M1: Easy to understand and clear for shopping guides M2: Diversity of customer entry methods
	YmM2: New User Registration Complexity	M3: New user registration complexity

	YmM3: Customer Entry Safety	M4: Supermarket Safety Assurance M5: Store customer identity filtering
	YmM4: Exception Information Handling	M6: Exception information processing
Intelligent shopping	YmN1: Hardware devices used in supermarkets	N1: Using hardware devices in supermarkets
	YmN2: Computer Vision	N2: Computer vision recognition of customer identity N3: Computer Vision Obtaining Customer Action Trajectories N4: Computer vision recognition of customer shopping actions N5: Computer vision recognition of goods N6: Image recognition technology
	YmN3:Sensor recognition system	N7: Composition of sensor recognition system
	YmN4: Identity recognition method	N8: Customer facial recognition identity N9: Customer skin color recognition identity
	YmN5: Speech Recognition	N10: Voice Recognition Customer Location N11: Voice recognition customer's approximate actions N12: Voice recognition customer behavior habits N13: Voice recognition customer stay time
	YmN6: Big Data	N14: Big Data Analysis to Determine User Preferences N15: Big Data Analysis Supermarket's Most Popular Products
	YmN7: Sensor Fusion	N16: Pressure sensor and weighing sensor to determine the current status of the product N17: Sensor fusion for customer and product matching
	YmN8: Intelligent Shopping	N18: Products automatically added to the app's virtual shopping basket
	YmN9: Shopping Identification Risk	N19: Consumer shopping behavior misjudgment
	YmO1: Intelligent Settlement	O1: Automatic settlement in designated settlement area O2: When the customer leaves the store, click on online payment or password free payment
Leave the store	YmP1: Timeliness of settlement information feedback	P1: Send transaction amount and other information to Amazon App P2: Timeliness of settlement information feedback